SCREENING ECOLOGICAL RISK ASSESSMENT FOR RICHARDSON FLAT TAILINGS PARK CITY, SUMMIT COUNTY, UTAH

February 2002

Prepared for the:

United States Environmental Protection Agency
Region VIII
999 18th Street, Suite 500
Denver, CO 80202

Prepared by:

Syracuse Research Corporation
Environmental Science Center - Denver
999 18th Street, Suite 1975
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TEXT

-DRAFT-

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LIST OF ACRONYMS AND ABBREVIATIONS

ASARCO	American Smelting and Refining Company
ATSDR	Agency for Toxic Substances and Disease Registry
AUF	Area Use Factor
AVS	Acid Volatile Sulfide
AWQC	Ambient Water Quality Criteria
BAF	Bioaccumulation Factors
BCC	Bioaccumulative Contaminant of Concern
BG	Background
BJC	Bechtel Jacobs Company
BOM	Bureau of Mines
BSAF	Biota-Sediment Accumulation Factors
BW	Body Weight
CCME	Canadian Council of Ministries of the Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act Information System
COPC	Contaminant of Potential Concern
DF	Dietary Fraction
dw	Dry Weight
E&E	Ecology & Environment, Inc.
EC50	Effective Concentration for 50% of the Study Organisms
ED50	Effective Dose for 50% of the Study Organisms
EPA	United States Environmental Protection Agency
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ERAGS	Ecological Risk Assessment Guidance for Superfund
ERL	Effects Range Low
ERM	Effects Range Median
GLWQG	Great Lakes Water Quality Guidance
GW	Groundwater
HI	Hazard Index
HQ	Hazard Quotient
HRS	Hazard Ranking System
IR	Ingestion Rate
IRIS	Integrated Risk Information System
LC50	Lethal Concentration for 50% of the Study Organisms
LOAEL	Lowest Observed Adverse Effect Level
LOEC	Lowest Observed Effect Concentration
MW	Monitoring Well
NEC	No Effect Concentration
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No Observed Adverse Effect Level

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

NPL	National Priorities List
OEA	OEA Research, Inc
ORNL	Oak Ridge National Laboratory
PCV	Park City Ventures
PEC	Probable Effects Concentration
PEL	Probable Effects Level
RCRA	Resource Conservation and Recovery Act
RF	Richardson Flat
RFD	Reference Dose
RFT	Richardson Flat Tailings
RI/FS	Remedial Investigation/Feasibility Study
RMC	Resource Management Consultants
SAP	Sampling and Analysis Plan
SCM	Site Conceptual Model
SEC	Sediment Effects Concentration
SEM	Simultaneously Extractable Metals
SERA	Screening Ecological Risk Assessment
SET	Severe Effects Threshold
SQG	Sediment Quality Guidelines
SW	Surface Water
TAL	Target Analyte List
TDS	Total Dissolved Solids
TEC	Threshold Effect Concentration
TEL	Threshold Effects Level
TMDL	Total Maximum Daily Load
TRV	Toxicity Reference Value
TSS	Total Suspended Solids
UCL	Upper Confidence Limit
UF	Uncertainty Factor
UPCM	United Park City Mines
URS	URS Operating Services, Inc.
USC	Upper Silver Creek
USDOI	United States Department of the Interior
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
XRF	X-Ray Fluorescence

1.0 INTRODUCTION

1.1 Purpose

This document is a screening level evaluation of potential risks to ecological receptors at the Richardson Flat Tailings (RFT) Site located near Park City, Utah (Figure 1-1). The purpose of the Screening Ecological Risk Assessment (SERA) is to identify the potential for adverse effects (risks) to ecological receptors resulting from exposure to contaminants released as a result of past mining activities. If potential risks are identified, then a more detailed Baseline Ecological Risk Assessment (ERA) may be warranted. The SERA process consists of four general steps: Problem Formulation, Exposure Assessment, Effects Assessment, and Risk Characterization (Figure 1-2).

The screening level problem formulation and risk characterization results are used to identify: 1) the need for a more detailed assessment; and, 2) the specific types of data needed to complete a more detailed assessment. The SERA is not intended to support any final quantitative conclusions about the magnitude of potential ecological risks identified in the screening-risk procedure(s).

1.2 Scope

This SERA is completed in accordance with current United States Environmental Protection Agency (USEPA) guidance for performing ecological risk assessments, in general (USEPA, 1998 and USEPA, 1992), and specifically, under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (USEPA, 1997). The SERA is completed according to the recommended eight-step process presented in the Ecological Risk Assessment Guidance for Superfund (ERAGS) (Figure 1-3). Figure 1-3 is shaded to show which portions of the ERAGS process are addressed by this document for the RFT Site.

In accordance with USEPA guidance, this SERA is intentionally simplified and conservative. The conservatism allows for elimination of only those contaminants, receptor pathways and environmental media that are below a level of concern and for which there is high confidence of no adverse effects (risks). However, if the SERA indicates that contaminant concentrations in a particular medium are within a range of concern, it is appropriate to conclude that a potential for risk does exist and that a more refined ecological risk evaluation is needed to identify and quantify the actual risk(s).

1.3 Organization

The SERA is organized into ten sections. In addition to this introductory section, the SERA contains the following chapters or sections:

Section 2 — This section provides the site characterization, which includes the site location, description, regulatory history, and environmental setting.

Section 3 This section provides a description of the available analytical data for the RFT Site including the nature and extent of contamination present in tailings, soils , surface water, sediments, and seeps (groundwater).

Section 4 This section provides the screening level problem formulation which includes discussions about the site conceptual model (SCM) selection of contaminants of potential concern (COPCs), and identification of assessment and measurement endpoints.

Section 5 This section presents the screening level ecological exposure assessment for aquatic invertebrates, fish, amphibians, terrestrial plants, soil invertebrates, and wildlife receptors.

Section 6 This section presents the screening level ecological effects assessment for aquatic invertebrates, fish, amphibians, terrestrial plants, soil invertebrates, and wildlife receptors. This includes descriptions of toxicity screening benchmarks for aquatic receptors (invertebrates, fish and amphibians) for surface water, seeps and sediments and for terrestrial plants and soil invertebrates for soils. The ecological effects assessment for wildlife identifies toxicity reference values (TRVs) or doses of contaminants by ingestion that are associated with no observed adverse effects or a lowest observed adverse effect.

Section 7 This section presents the screening level risk characterization for aquatic invertebrates, fish, amphibians, terrestrial plants, soil invertebrates, and wildlife receptors. aquatic and terrestrial wildlife receptors.

Section 8 This section presents and discusses the uncertainties associated with each of the steps of the SERA.

Section 9 This section discusses the data gaps present in the SERA and provides recommendations for the collection of data and analyses for completing a more detailed or baseline ecological risk assessment (ERA). The recommendations are based on the findings of the SERA.

Section 10 This section presents references used in the SERA.

2.0 SITE CHARACTERIZATION

2.1 Site Location

The RFT Site is located 1.5 miles northeast of Park City, Utah occupying about 700 acres in a small valley in Summit County, Utah (Figure 1-1). The RFT site is part of the Park City Mining District where silver-laden ore was mined and milled from the Keetley Ontario Mine as well as other mining operations (RMC, 2001a). Tailings were deposited into an impoundment covering 160 acres of the 700 acre property just east of Silver Creek. Tailings were deposited to the impoundment from the mill by use of a slurry pipeline from 1975 through 1981. Mining and milling operations ended in 1982.

2.2 Site Description

Tailings were first placed on RFT Site prior to 1950 (RMC, 2000a). Historical aerial photos confirm that tailings have been present at the flood plain tailings pile as early as 1953 (USEPA, 1991). The mill tailings present consist of mostly of sand-sized particles of carbonate rock with some minerals containing silver, lead, zinc and other metals. Few specific details are available concerning the configuration and operation of the historic tailings pond (prior to 1950) but certain elements are apparent. From time to time, tailings were transported to the Site through three distinct low areas on the southeast portion of the Site. Over the course of time, tailings materials settled out into the low areas that were ultimately left outside and south of the present impoundment area constructed in 1973 to 1974 (RMC, 2001b).

In 1970, Park City Ventures (PCV), a joint venture partnership between Anaconda Copper Company and American Smelting and Refining Company (ASARCO) entered into a lease agreement with United Park to use the Site for disposal of additional mill tailings from renewed mining in the area. PCV contracted with Dames & Moore to provide construction specifications for reconstruction of the Site for continued use as a tailings impoundment (Dames & Moore, 1974). The state of Utah approved the Dames & Moore plan and the current impoundment area was constructed in 1974 (RMC, 2000a). Before disposing of tailings on the Site, PCV installed a large earthen embankment along the western edge of the existing tailings impoundment and constructed perimeter containment dike structures along the southern and eastern borders of the impoundment to allow storage of additional tailings. PCV also installed a diversion ditch system along the higher slopes north of the impoundment and outside of the containment dike along the east and south perimeter of the impoundment to prevent surface runoff from surrounding land from entering the impoundment (RMC, 2001b). Dames & Moore recommended that special engineered seepage control devices be installed at the base of the main embankment. PCV did not follow this recommendation (Dames & Moore, 1974).

PCV conveyed tailings to the impoundment by a slurry pipeline from its mill facility located south of the Site. Over the course of operation, approximately 420,000 tons of tailings were disposed of at the Site. PCV failed to follow recommendations for disposal of the slurry in the impoundment (to place tailings along the perimeter of the impoundment and move towards the center) and placed a large volume of tailings near the center of the impoundment in a large, high-profile, cone-shaped feature. After cessation of operations in 1982, the presence of the cone-shaped feature resulted in prevailing winds form cutting into the tailings and the tailings becoming wind-borne (RMC, 2001b).

The RFT Site is currently under the ownership of United Park City Mines (UPCM) (RMC, 2000a). UPCM is a consolidation of Silver King Coalition Mines Company and Park Utah Consolidated Mines Company, formed in 1953 (RMC, 2000a).

2.2.1 Sources

There are two known sources of contamination at the RFT Site. These include the tailings impoundment previously described and a flood plain tailings pile. The flood plains tailings pile is located immediately west of the tailings impoundment and covers about 6 acres along the banks of Silver Creek (USEPA, 1991). This source is reported to be located on the western side of Silver Creek about 300 feet upstream of the confluence of Silver Creek with the wetland area and extends from there for about 2500 feet upstream. The USEPA and the State of Utah have both observed tailings entering Silver Creek from the flood plain tailings pile (USEPA, 1991). According to analyses performed in 1985 and 1989, the flood plain tailings pile contains arsenic, cadmium, copper, lead, mercury, silver, and zinc (USEPA, 1991).

2.2.2 Site Features

The Focused Remedial Investigation/Feasibility Study (RI/FS) Workplan prepared by RMC in May 2000, provides detailed information on the RFT Site features (Figure 2-1). Information pertaining to the main embankment and containment dikes, the diversion ditches and off-impoundment tailings is summarized in the following subsections.

2.2.2.1 Main Embankment and Containment Dikes

The majority of the tailings at the RFT Site are contained in a closed basin, with a large, earth, embankment in place along the western edge of the Site (Figure 2-1). The "main embankment" is vegetated and is approximately 40 feet wide at the top, 800 feet long, and has a maximum height of 25 feet. This embankment is designed to allow water to seep from the impoundment to relieve hydraulic pressure on the embankment. Currently, surface water is present in the form of a seep located near the north end of the base. A series of man-made containment dikes contain the tailings along the southern and eastern perimeter of the impoundment. The northern edge of the impoundment is naturally higher than the perimeter dikes (RMC, 2000a).

2.2.2.2 Diversion Ditches

A diversion ditch system borders the north, south, and east sides of the impoundment to prevent runoff from the surrounding land from entering the impoundment. Precipitation falling on the impoundment area creates a limited volume of seasonal surface water (Figure 2-1). The north diversion ditch collects snowmelt and storm water runoff from upslope, undisturbed areas north of the impoundment and carries it in an easterly direction towards origin of the south diversion ditch. An unnamed ephemeral drainage to the southeast of the impoundment also enters the south diversion ditch at this point. Additional water from spring snowmelt and storm water runoff enters the south diversion ditch from other areas lying south of the impoundment at a point near the southeast corner of the diversion ditch structure. Water in the south diversion ditch flows from east to west and ultimately empties into Silver Creek just upstream of Highway 189 near the north border of the Site. Water flow from the south diversion ditch into Silver Creek occurs during the higher water periods of the year (RMC, 2000a).

2.2.2.3 Off-Impoundment Tailings

Additional tailings materials are present outside and to the south of the current impoundment area. During historic operations of the tailings pond, tailings accumulated in three naturally low areas adjacent to the property that eventually became the impoundment. In the 1970s, when PCV constructed the perimeter dike and diversion ditch along the south perimeter of the impoundment, tailings present in the three low areas were left in place, outside of the present impoundment. Starting in 1983, United Park reportedly covered most of these tailings outside of the current impoundment with a low permeability, vegetated soil cover. Other types of clean fill material, imported from construction work in Park City, were also used to cover the tailings outside of the impoundment. The cover in some of these areas is reported to be as thick as 10 to 15 feet (RMC, 2000a). However, recent surveys of off-impoundment cover soils indicate that at some locations soil cover is absent leaving exposed surface tailings and in other places the soil cover is less than a few inches (RMC, 2001a).

2.2.3 Site Activities

UPCM and others have conducted certain efforts at the RFT Site to support investigation of integrity or closure. These activities are briefly described in the following subsections.

2.2.3.1 Impoundment Integrity Analyses

Noranda Mining, Inc. (Noranda) leased the RFT Property from UPCM in 1980 (RMC, 2000a). Shortly after Noranda entered into the lease agreement, Dames & Moore was contracted to conduct an impoundment integrity investigation. Although several construction flaws are noted, including the oversteeping of the main embankment along various locations, Dames & Moore concludes that the main embankment and containment dikes are in no immediate threat of failure. Dames & Moore once again recommends the installation of seepage control systems at the base of the main embankment (RMC, 2000a). Noranda does not follow this recommendation. Noranda disposed of 70,000 tons of additional tailings material and ceased operations in 1982. No new tailings have been placed at the Site since that time (RMC, 2000a).

2.2.3.2 Soil Cover of Tailings

Starting in 1983, UPCM began placing soil cover on tailings outside of the impoundment, located in three low areas south of the south diversion ditch (Figure 2-1). By 1985, the tailings impoundment had dried out enough in certain areas to support heavy equipment and UPCM began installing soil cover material over those portions. The cover soils are reported to be clay-rich and came from both the Park City area and from within the RFT Site (RMC, 2000a).

Between 1985 and 1988, UPCM also placed soil cover around the cone shaped tailings structure inside the impoundment area at locations where it had dried out enough to support heavy equipment. The primary objective of placing the soil cover was to prevent prevailing winds from cutting into the cone-shaped tailings By 1988, this work was completed and UPCM began a more aggressive program to cover all exposed tailings. It is reported that at least 12 inches of low-permeability, clay cover material was placed in the impoundment and that the soil cover was then vegetated (RMC, 2000a). More recent inspection of the cover soils at the main impoundment and off-impoundment indicate a shallow soil cover in some areas (less than 12 inches) and no soil cover in other locations (RMC, 2001a).

By 1992, to soil cover work was completed (RMC, 2000a). Shortly after completion, E&E (1993) completed a soil depth survey within the impoundment and an inspection of the main embankment. X-Ray Fluorescence (XRF) was used to confirm the visual contrast between top soil and the tailings below (E&E, 1993). E&E (1993) determined that on average, cover soils varied between less than 6 inches and 14 inches in depth. Areas in which cover soils were known to be more than 3 feet in depth were not surveyed. For the 29 locations studied, one exhibited exposed tailings. As a result, UPCM placed additional soil in this area (RMC, 2000a). More recent soil cover surveys for the main impoundment, however, indicate that at some locations the soil cover is less than 12 inches in depth (RMC, 2001a; 2001b).

2.2.2.3 Wedge Buttress Reinforcement

In an effort to correct the over-steepened portions of the main embankment, UPCM proposes to design the installation of a wedge buttress. The buttress will enhance the long-term effectiveness of the final closure remedy for the Site. UPCM will evaluate the condition of the main embankment during the RI/FS, and then prepare construction design specifications as part of the final remedial design process. Data from the seep located at the base of the main embankment may need to be gathered in order to develop an appropriate wedge buttress design (RMC, 2000a).

2.2.2.4 Fencing

In the mid 1980's, UPCM installed a fence along most of the Site boundary, including the entire impoundment and much of the property south of the impoundment. The fence was placed to restrict access to the Site. UPCM reports it will maintain the fence in good repair and will continue to control Site access until such time limited access is no longer necessary (RMC, 2000a).

2.2.2.5 Diversion Ditch Reconstruction

In 1992 and 1993, UPCM reconstructed the south diversion ditch by decreasing the slope of its banks from nearly vertical to a more gradual slope. UPCM placed a clay soil cover over the re-sloped banks down to and including areas of the banks underwater. The existing ditch banks were re-vegetated and the bottom of the ditch was not disturbed during these efforts. In May of 1999, United Park reconstructed the north diversion ditch along its entire length in the same manner (RMC, 2000a).

2.3 Regulatory History

The RFT Site was first proposed for the National Priorities List (NPL) on June 24, 1988. The original Hazard Ranking System (HRS) score of 50.23 was based on surface water and air migration pathways (USEPA, 1991). Areas evaluated in the HRS included the impoundment and adjacent areas (USEPA, 1991). Based on public comments, the site was dropped from consideration for the NPL on February 11, 1991 (USEPA, 1991). The HRS scoring criteria for surface water migration pathways were revised in 1992. The USEPA is currently proposing the site for a second NPL consideration under the revised HRS (USEPA, 1991). Along with the impoundment area and adjacent areas, the new proposal includes the Park City Municipal Landfill and the Silver Creek flood plain area (RMC, 2000a).

2.4 Site Environmental Setting

2.4.1 Topography and Surrounding Land Use

The site is located in a rural area whose topography is characterized by a broad valley with undeveloped rangeland. Silver Creek is located within a few hundred feet from the main tailings impoundment. This perennial stream drains other historic tailing ponds in the Park City area (Mason, 1989). Silver Creek originates in an upper mountain zone where access is limited to recreational users. As Silver Creek passes through Park City and in the surrounding suburban areas, the land use is primarily residential and commercial changing to recreational and agricultural downstream to its confluence with the Weber River (RMC, 2001a).

2.4.2 Geology and Hydrogeology

2.4.2.1 Geology

The RFT Site is located in the Wasatch Range Section of the Middle Rocky Mountain Physiographic Province in north-central Utah in an area composed of a complex fold and thrust belt that is covered over with igneous rock (RMC, 2000a; 2000b). The sedimentary bedrock, which dates to the Paleozoic and Mesozoic age, is covered by a thick layer of extruded igneous rock that dips approximately 25 to 60 degrees to the north and strikes northeast-southwest (Bromfield and Crittenden, 1971). Tertiary gravels and igneous rocks cover the Mesozoic sedimentary rocks (RMC, 2001a). There are no known faults near the RFT Site.

Alluvial and colluvial sediments lie 30 to 50 feet deep beneath the tailings on site. These sediments are product of the erosion of neighboring and underlying igneous extrusions. Borehole data has shown that these sediments consist of: 2-5 feet of soft, organic, and clay rich topsoil; 1-30 feet of mixed fine-grained silt and clay; 4 feet of sand and gravel; highly weather, volcanic breccia which is composed of soft, tight, sandy and silty clay grading to harder fractured volcanic rock (RMC, 2000b). The unconsolidated valley fill is reported to range in thickness from a few feet adjacent to hills and mountains to at least 260 feet, centrally in valleys (Mason, 1989)

2.4.2.2 Hydrogeology

In 1999, UPCM contracted Weston Engineering, Inc. (Weston) to conduct a hydogeological survey of the site. The hydrogeology in the area consists of shallow alluvial aquifers located in the alluvial and colluvial material as well as the deeper Silver Creek Breccia bedrock aquifer located in the Keetley volcanics (RMC, 2000b). The shallow aquifers are found fifteen to thirty feet below ground surface in gravelly clay. The shallow aquifers' hydraulic gradients parallel topography (south to north) except at the southern boundary of the tailings embankment where flow changes to the northwest due to diversion ditches. The hydrogeology of the Site area has been described in a separate report (Weston, 1999).

2.4.2.3 Hydrology

Silver Creek flows approximately 500 feet from the main embankment along the west edge of the Site (RMC, 2000a). The headwaters of Silver Creek are comprised of three major drainages in the Upper Silver Creek Watershed; the Ontario Canyon, the Empire Canyon and Deer Valley. Flows from Ontario and Empire Canyons occur in the late spring to early summer months in response to snowmelt and rainfall, while Deer Valley flows appear to be perennial and originate from snowmelt and springs (RMC, 2000b). Surface water runoffs for this watershed are lower than that of comparable mountain watersheds which are less fractured and may have a more developed layer of unconsolidated materials (Brooks et al., 1998). Overall, runoff and precipitation flows from Empire and Ontario Canyons are low compared to the substantially large flow contributed by Deer Valley (USEPA, 2001a). The major influence on water flow in Silver Creek near the RFT Site is the Pace-Homer (Dority Springs) Ditch, which derives most of its flow from groundwater (USEPA, 2001a). The outflow from the Pace-Homer Ditch enters Silver Creek at several locations across the Prospector Square area. Significant riparian zones and wetlands exist near the RFT Site in areas that historically consisted of accumulated tailings piles.

2.4.3 Climate

Richardson Flat is located in north-central Utah. The average monthly precipitation is approximately 3.64 inches with an average annual precipitation of 43.68 inches (www.weather.com - accessed 08/5/01). The average monthly temperature ranges from 19°F to 58°F. with an average for the year of 36°F. Elevations near the RFT Site range from 6,930 to 9,075 feet above sea level (RMC, 2000b).

2.4.4 Ecology

There is very limited information concerning the biological communities present at the RFT Site. This section summarizes the information from reports available for review at the time of the SERA.

2.4.4.1 Aquatic Community

In accordance with the State of Utah surface water code, the Weber River from the Stoddard diversion to its headwaters (including Silver Creek) is classified as a cold water fishery (3A) and is protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in the food chain. Elevated zinc concentrations, in comparison to the State aquatic life standard for 3A designated streams, have consistently been reported in Silver Creek.

According the public health assessment conducted by ATSDR there are few studies available concerning fish in Silver Creek. A survey conducted in 1954 found a small number of trout in Silver Creek (ATSDR, 1994) but in 1970, fish were not present during electroshocking (ATSDR, 1994). More recently, biologists have reported cutthroat troat in Silver Creek, however, information regarding number of individuals or sampling locations are not available (E&E, 1991). A 1986 investigation produced no fish but pan-sized trout were reportedly seen in Silver Creek near the RFT Site in the spring of 1992 (USEPA, 1993c; ATSDR, 1994).

2.4.4.2 Terrestrial Community

There was no information located pertaining to the plant and terrestrial wildlife communities (mammals and birds) present at the RFT Site.

2.4.4.3 Threatened or Endangered Species

Federally listed threatened or endangered wildlife species that are known or are suspected to inhabit Summit County include the bald eagle (*Haliaeetus leucocephalus*), the Canada lynx (*Lynx canadensis*) and possibly the whooping crane (*Grus americana*) and the black-footed ferret (*Mustela nigripes*) (Utah Division of Wildlife website - accessed 08/03/01). No threatened or endangered plant species were identified.

3.0 DATA SUMMARY AND EVALUATION

The SERA is based on the available analytical and physical data from investigations completed within the RFT Site area. A summary of the raw data is provided as Appendix A. These results represent the known nature and extent of contamination and are used as the basis of the SERA.

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3.1 Tailings Data

As previously discussed, contamination at the RFT Site originated from the deposition of tailings within and outside of an impoundment. In July 1989, one tailings sample from the main impoundment area (stratified depths from 1-18 inches) and five tailings samples (0-6 inches) from flood plain areas were collected and data were presented in the HRS (USEPA, 1991). These samples were analyzed for total arsenic, cadmium, copper, lead, mercury, silver and zinc.

In May 2001, RMC collected tailings samples from the three locations within the impoundment at 1 foot depth intervals (beginning from the bottom of the cover soils to a depth of 5 feet). Figure 3-1 identifies these locations as green circles on the impoundment. Samples were analyzed for aluminum, antimony, arsenic, cadmium, chromium, copper, iron, lead, mercury, selenium, silver, and zinc. These samples were collected to evaluate the long-term fate of metals in tailings and the chemical stability of the tailings (RMC, 2001a).

Tailings disposal is also present in areas located outside the impoundment (Figure 3-1) but the spatial extent of these areas are not well defined. In June 2001, RMC collected tailings samples from locations south of the south diversion ditch in an effort to determine the extent of tailings disposal. This study was also completed to evaluate soil cover thickness, and if the tailings were contributing to zinc concentrations in the south diversion ditch. Samples were analyzed for aluminum, antimony, arsenic, cadmium, chromium, copper, iron, lead, mercury, selenium, silver, and zinc.

Analytical results for these three data sets are provided in Table 3-1. In order to evaluate the most current site conditions, the tailings data collected in July 1989 for the HRS are excluded from the SERA. Data included in the SERA are limited to tailings data collected by RMC through December 2001.

3.2 Soils Data

3.2.1 On-Impoundment Soils

In August 1992, Ecology & Environment, Inc. (E&E), under direction from EPA, investigated the RFT Site with respect to immediate threats to human health or the environment. The depth of soil cover was determined at 29 locations on the impoundment (based on an approximate grid pattern of 400 ft by 400 ft). At six of these locations, samples were analyzed for Target Analyte List (TAL) metals. These analytical results are presented in Table 3-2. Each of the samples, with the exception of sample RF-SO-3, are representative of cover soils on the impoundment in 1992. Sample RF-SO-3, was collected in an area of salt grass not yet covered by UPCM and is representative of tailings (E&E, 1993). Subsequently, UPCM placed additional soil cover in areas with thin cover (as identified by E&E, 1993) and on other areas to support site closure efforts (RMC, 2001a).

Currently, the cone-shaped tailings impoundment is reported to be covered with soil and vegetation with no areas of exposed tailings (RMC, 2001a). However, the extent, thickness, and chemical characteristics of the cover soils are not well defined. In May 2001, RMC collected 41 cover soils from 6 transects based on a 500 ft by 500 ft grid across the impoundment at a depth of 0-2 inches (distinct locations are identified as A through I). Figure 3-1 shows the locations at each grid node. Additional depth samples, ranging from 5 to 18 inches, were collected at 11 of these locations. All samples were analyzed for arsenic and lead with 20% of the samples analyzed for all RCRA metals. The analytical results for on impoundment cover soils are provided as Table 3-2.

In order to evaluate the most current Site conditions, the cover soils data collected by E&E in August 1992 are excluded from the SERA. The risk evaluation in the SERA is based on data for on-impoundment cover soils collected by RMC through December 2001.

3.2.2 Off-Impoundment Soils

Historically, prevailing winds from the southeast carried tailings from the impoundment and deposited them in the surrounding areas. In an effort to assess the extent and potential environmental impact of these wind-blown tailings, off-impoundment soil samples were collected from one transect north (T1) and two transects south (T2 and T3) of the RFT Site in May of 2001 (Figure 3-2). RMC collected eight distinct samples at T1 (A through H) and ten distinct samples at T2 and T3 (A through J) at two depth intervals (0-2 inches and 1-6 inches). All samples were analyzed for arsenic and lead with 20 % of the samples analyzed for all RCRA metals. Analytical results for these off-impoundment soils are provided as Table 3-3.

In September 2001, eight surface soil samples (0 to 2 inches in depth) were collected from locations surrounding the RFT Site to better determine the study area boundary (Figure 3-3). These samples were analyzed for arsenic and lead and the analytical results are provided in Table 3-3. Concentrations of arsenic and lead in sample SAB-6 are elevated compared to other results. Based on these results, it is assumed that this sample is representative of tailings and it is excluded from inclusion in the off-impoundment soils dataset (RMC, 2001b). The SERA is limited to off-impoundment soils collected by RMC through December 2001.

3.2.3 Background Soils

In order to determine the concentrations of metals in areas not affected by wind-blown tailings from the RFT Site, RMC collected background samples from areas not impacted by tailings deposition. It is important to note that these samples are representative of anthropogenic, non-site related levels, and do not represent "pristine" (not influenced by human activity) environmental levels.

Grab samples were collected at a depth of 0 to 2 inches from each of eleven locations (Figure 3-4) and were analyzed for arsenic and lead with 20% of the samples (BG8 and BG10) analyzed for all RCRA metals. The results are presented in Table 3-4. The arsenic and lead concentrations in sample BG11 are more than 30 times and 100 times greater, respectively, than those observed in other samples. This sampling location was later reported to be representative of tailings and is excluded from the background soils data set (personal communication, BTAG Mtg, 8/9/01).

3.3 Surface Water Data

Surface water data were compiled from five sources including E&E (1993), Utah water quality monitoring , USEPA (2001a), UPCM surface water monitoring, and RMC monthly sampling . A description of the surface water data from each source is provided in the following subsections.

For the purposes of conducting the SERA, surface water data from Silver Creek are segregated into two reaches; upstream and downstream of the RFT Site. To be consistent with the upstream/downstream designations used by UPCM, the cut-off point for these reaches is the rail trail bridge located northeast of State Highway 40 near the main embankment. In order to evaluate the most current site conditions, surface water data for the south diversion ditch are limited to samples collected after ditch reconstruction (1993 to present).

Ecology & Environment, Inc. (1993)

In August 1992, E&E collected surface water samples from Silver Creek and the south diversion ditch. As presented in Figure 3-5, six samples were collected along Silver Creek (RF-SW-1 to RF-SW-6) and two samples were collected from the south diversion ditch (RF-SW-7 and RF-SW-8). Analytical results for these surface water samples are provided as Table 3-5.

Utah Water Quality Monitoring (STORET)

Water quality monitoring data for several stations along Silver Creek were obtained electronically from an EPA STORET download query (Modernized Version). Data is available from nine locations on Silver Creek. Samples are collected and analyzed monthly for water quality parameters such as total hardness, pH, and temperature, as well as total recoverable and dissolved metals including arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc. Information for each of the Silver Creek stations is provided in the following text table. Analytical results are provided in Appendix A.

Station ID	Location Description	Latitude	Longitude	Sampling Dates
492674	Silver Creek at Farm Crossing in Atkinson	40.742167	-111.474167	12-Jan-68 to 13-Apr-00
492675	Silver Creek at Wanship above confluence with Weber River	40.813000	-111.401667	20-Dec-79 to 17-Jun-99
492676	Silver Creek 2 miles north of Atkinson	40.768500	-111.467667	21-Aug-81 to 11-May-89

Station ID	Location Description	Latitude	Longitude	Sampling Dates
492677	Silver Creek at I-80 Crossing at Atkinson east of Silver Creek Junction	40.743833	-111.473000	20-Dec-79 to 22-Jan-92
492679	Silver Creek at Waste Water Treatment Plant	40.735167	-111.474667	04-Jun-87 to 13-Jun-00
492680	Silver Creek above Atkinson	40.735167	-111.475167	17-Sep-81 to 13-Apr-00
492685	Silver Creek at US40 Crossing east of Park City	40.683000	-111.456000	02-May-75 to17-Jun-99
492694	Silver Creek at Railroad Crossing below Park City above Landfill	40.658000	-111.501833	20-Dec-79 to 28-Nov-83
492695	Silver Creek at City Park above Prospector Square	40.654333	-111.501667	06-Aug-97 to 17-Jun-99

USEPA (2001a) Silver Creek Watershed Sampling

In 2000, EPA completed an investigation of the Silver Creek watershed to better characterize the sources of heavy metals and to evaluate the total maximum daily load (TMDL) (Figure 3-6). A total of 31 surface water sampling locations are available from the watershed study for Silver Creek and its headwaters in Empire Canyon, Ontario Canyon, Deer Valley (Figure 3-7). For the purposes of the SERA only data from sampling stations on the lower reaches of Silver Creek (USC-1 through USC-7) below Prospector Square are used for the risk evaluation. Surface water samples for USC-4 were collected from the south diversion ditch on the RFT Site. Samples were collected in May and September 2000, respectively, to account for high (peak spring runoff) and low flow (fall or winter seasons). Some locations were re-sampled in November 2000 due to problems with mercury analysis. Average concentrations from each sampling location are provided in Table 3-6.

UPCM Monitoring

Since 1975, UPCM has collected surface water samples from the south diversion ditch (N5), and Silver Creek upstream (N4) and downstream (N6) of the confluence with the south diversion ditch (Figure 3-8). Surface water samples were collected monthly (usually from April to November) and analyzed for copper, cyanide, lead, mercury, manganese, zinc, total suspended solids (TSS) and total dissolved solids (TDS). The range of concentrations measured at each sampling location are provided in Table 3-7. At the time of the SERA, surface water data collected prior to April 1982 was not available for review.

RMC Monthly Sampling (RMC, 2001c)

Since May 1999, RMC collects monthly surface water from several locations along Silver Creek, the south diversion ditch, the unnamed drainages flowing into the south diversion ditch, and ponded areas at the RFT

Site. Specific locations are identified in Figure 3-9 and detailed station information is summarized in the following text table. Surface water samples were analyzed for total recoverable and dissolved TAL metals and water quality parameters. Average concentrations from each sampling location are provided in Table 3-8.

Station ID	Location Description	Sampling Dates
RF-1	Unnamed drainage flowing into the south diversion ditch	19-May-99 to 7-May-01
RF-2	South diversion ditch	19-May-99 to 7-May-01
RF-3	Unnamed drainage flowing into the south diversion ditch	19-May-99 only
RF-3-2	Unnamed drainage flowing into the south diversion ditch	4-Apr-01 to 5-Jun-01
RF-4	South diversion ditch	19-May-99 to 9-Jul-01
RF-5	South diversion ditch	19-May-99 to 7-Aug-01
RF-5-4	South diversion ditch*	4-Apr-01 to 7-May-01
RF-6	South diversion ditch	19-May-99 to 18-Sep-00
RF-6-2	South diversion ditch	9-Jun-99 to 3-Dec-01
RF-7	Silver Creek upstream of confluence with south diversion ditch	19-May-99 to 7-Nov-00
RF-7-2	Silver Creek upstream of confluence with south diversion ditch	9-Jun-99 to 3-Dec-01
RF-8	Silver Creek downstream of the confluence with south diversion ditch	19-May-99 to 3-Dec-01
RF-8-2	Silver Creek downstream of the confluence with south diversion ditch*	9-Jun-99 only
RF-9	Ponded water on the tailings impoundment	19-May-99 only
RF-10	Unnamed drainage flowing into south diversion ditch	9-Jun-99 only

*Assumed; actual sampling locations not provided on map.

3.4 Sediment Data

Sediment data are compiled for the SERA from three separate sources including E&E (1993), USEPA (2001a) and RMC monthly sampling. A description of the sediment data from each source is provided in the following text table.

Use of surface water data for the south diversion ditch in the SERA is limited to samples collected after ditch bank modification. This limitation is not, however, placed on the use of sediment data. During reconstruction, UPCM did not disturb the bottom of the ditch bed (RMC, 2001a) thus the existing sediments were not disturbed and constraining use of the is not necessary.

As with the surface water data set, Silver Creek sediments are designated as either upstream or downstream of the RFT Site using the same cut-off point for these reaches at the rail trail bridge located northeast of State Highway 40 near the main embankment.

Ecology & Environment, Inc. (1993)

In August 1992, E&E collected four sediment samples (RF-SD-01 to RF-SD-04) from the south diversion ditch "wetlands" area located at the base of the main embankment and Silver Creek (Figure 3-5). Water flow through this wetlands area is primarily from the south diversion ditch, although some seepage from the impoundment area may influence the flow and chemistry (E&E, 1993). Analytical results for these sediment samples are provided in Table 3-9. Based on the ratios of chemicals in tailings to compared to those in the wetlands sediments, E&E concluded that the sediments in the wetlands area are tailings material from the impoundment (E&E, 1993).

USEPA (2001a) Watershed Sampling

EPA collected sediment samples from 16 locations in the Silver Creek watershed (Figure 3-7). These samples were staggered across the watershed and co-located with specific surface water sampling sites to determine the relative level of metals throughout the system and evaluate interactions with surface water (USEPA, 2001a). At each location, both a surface and sub-surface (0-12 inches) sample was collected and analyzed for heavy metals. Data used in the SERA are limited to sampling stations on the lower reaches of Silver Creek (USC-1, USC-2, USC-5, USC-6, USC-7) below Prospector Square. Analytical results for these sediment samples are provided in Table 3-9.

RMC Monthly Sampling (RMC, 2001c)

In May 2001, RMC sampled sediments at six locations (RF-SD-1 to RF-SD-6) along the length of the south diversion ditch at a depth of 0 to 6 inches. Each sediment sample is designated by a blue 'X' in Figure 3-1. These samples were collected to evaluate the long-term effectiveness of the wetland system to remove metals in the water and to aid in the determination of the source of metals in water flowing from the diversion ditch (RMC, 2001a). Analytical results for the south diversion ditch sediments are provided in Table 3-9.

3.5 Seep Data

Because the main embankment is designed to allow water to seep from the impoundment to relieve hydraulic pressure, it is likely that metals leach from tailings into groundwater at the RFT Site. At the RFT Site, a small seep (flow of gallons per day) is located at the northern base of the main embankment (RMC, 2000a). Currently, no water or sediment data exist for this seep.

3.6 Groundwater Data

Since 1973, PCV and UPCM have collecting groundwater data quarterly from monitoring wells MW-1, MW-2, and MW-3 (RMC, 2000a). After their installation in 1976, PCV also began collecting groundwater from wells MW-4, MW-5, MW-6. E&E began collecting additional groundwater data in 1984 from a well (RT-1) installed up gradient of the main embankment. E&E also sampled the two existing down gradient monitoring wells MW-1 and either MW-5 or MW-6 . [It is unclear as to which well, MW-5 or MW-6, was sampled.] Well MW-2 was buried during the installation of wells MW-4, MW-5, MW-6 in 1976. The USEPA contracted E&E in 1992 to collect ground water samples from three additional locations (RF-GW-04, RF-GW-05, and RF-GW-09). The location of groundwater monitoring wells is provided on Figure 3-9.

Because measured seep concentrations are not available, measured concentrations from groundwater monitoring wells at the base of the main embankment near the seep are used to estimate seep water concentrations. Groundwater data is available for several site monitoring wells (MW-01, MW-03 through MW-06) located at the base of the main embankment. In addition, data from an upgradient monitoring well (RT-1) is used to estimate upgradient groundwater concentrations. The range of concentrations measured for these monitoring wells are presented in Table 3-10.

3.7 Biological Tissue Data

At the time of the SERA, the analyses of contaminant concentrations in biological tissues (aquatic or terrestrial) were not available from existing data reports and literature.

3.8 Summary of Analytical Data

Table 3-11 provides a summary of the analytical data available for the SERA. This table compares the analytical parameters available for the environmental media sampled and analyzed. As previously described, there are eight sources of sampling data including: RMC (2000a), EPA (1991); E&E (1993); EPA (2001a); RMC(2001a); RMC (2001c); UPCM and STORET. These programs do not have one common list of analytes for all environmental media. Table 3-11 provides a side-by-side comparison of the parameters available for each media type from each source of sampling data.

4.0 SCREENING LEVEL PROBLEM FORMULATION

Problem formulation is a systematic planning step that identifies the major factors to be considered in the SERA (USEPA, 1997). The problem formulation includes an evaluation of the fate and transport of contaminants of potential concern from waste sources to the receptors and identification of exposure pathways for the receptors. These factors are combined to present a site-conceptual model. Assessment endpoints are then defined and measurement endpoints developed that are the basis for the SERA. The site-conceptual model for the RFT Site was developed based on the ecological site conceptual model presented by RMC in the RI Sampling and Analysis Plan (RMC, 2001a). The revised ecological site conceptual model is described in the following subsections. Additions and changes made in comparison to the original model is discussed in Section 4.4.

4.1 Site Conceptual Model

Figure 4-1 presents a screening level or preliminary ecological site conceptual model (SCM) which details the significant pathways by which site-related contaminants may be transported to other environmental media. The SCM also illustrates the exposure pathways by which ecological receptors may reasonably be exposed to site-related contaminants. Exposure pathways are classified as follows:

- Pathways not complete - Incomplete exposure pathways (i.e., those that are not known to occur) are shown as open boxes and are not evaluated in the SERA.

- Pathways complete but considered insignificant - Exposure pathways considered to be complete but are considered to be insignificant compared to other exposure pathways. These pathways are shown as boxes with vertical hatched lines and are not evaluated in the SERA.

- Pathways complete but risk evaluation impossible - Exposure pathways are complete, but exposure and/or toxicity data are not available to evaluate risks These pathways are shown as boxes with diagonal hatched lines and are not evaluated in the SERA.

- Exposure pathways complete - These exposure pathways are considered to be potentially complete and are evaluated quantitatively in the SERA. These pathways are shown as dark shaded boxes.

The following sections present a more detailed description of sources, transport and migration pathways and exposure pathways for ecological receptors at the RFT Site.

4.1.1 Source Media

As presented in Section 3, contamination exists in several environmental media (surface water, sediment, seep, and soil) at the RFT Site. This contamination originated from a tailings impoundment and other tailings deposits both inside and outside the main impoundment area (Figure 2-1). Currently both the main tailings impoundment and the tailings deposits outside of the impoundment are reported to be covered with a clay soil cover cap (RMC, 2001b). However, recent mapping and sampling data suggest that some of these tailings on and off the impoundment are not uniformly covered. As seen in Table 4-1, soil cover depths for the main impoundment range from 3 inches to 11 feet (RMC, 2001b). Based on arsenic and lead concentrations for the off-impoundment soil samples collected from 0 to 6 inches (Figure 4-2), the observed soil cover is shallow in some areas south of the diversion ditch and absent in other locations. Although these two tailings sources (on and off the impoundment) are separated spatially, the release mechanisms and resulting secondary source medium and exposure media for ecological receptors are generally the same (Figure 4-1).

4.1.2 Migration Pathways (Release Mechanisms)

Contamination in a source medium can migrate and cause contamination in other parts of the environment by pathways that involve either physical transport from one location to another. These transport processes are referred to as release mechanisms. The potential release mechanisms from the source (tailings) to secondary source media and exposure media for ecological receptors are depicted in Figure 4-1. These include historical and current wind erosion, penetration of the soils cap (i.e.: burrowing animals, plant roots), mixing of the cover soils with tailings, infiltration of rainwater and snowmelt, runoff associated with rainwater and snowmelt, and leaching from soils as a result of infiltration of rainwater and snowmelt.

4.1.3 Secondary Source Media

Under dry conditions, particles of either tailings or cover material mixed with tailings can be eroded by wind and transported to adjacent areas resulting in suspended soil/dust/tailings, or contamination of surrounding soil with tailings or a mixture of soil cover and tailings.

The contaminants present in tailings and or soil can be transported by water from surface runoff into surface water bodies (e.g., streams, wetlands and impoundments). This may result in deposition of contaminants absorbed or adsorbed to soil particles as sediments. The dissolved contaminants migrating in runoff water or deposited with sediments may be released to surface waters. Dissolved contaminants in soil may also leach to groundwater, with subsequent transport to surface water as seeps and further possible transfer to surface water or sediments.

Contaminants in surface water, sediment, soil, or seeps can enter the food chain if organisms and plants take up or accumulate contaminants from these media into tissues, which are then consumed by other animals.

4.1.4 Potentially Exposed Receptors and Exposure Pathways

Ecological receptors may be potentially exposed to contaminants in any one of seven exposure media at the RFT Site (Figure 4-1). These exposure media to which ecological receptors may be exposed include suspended soil or dust particles, surface soil/tailings, terrestrial prey items (food chain), sediment, aquatic prey items (food chain), surface water and seeps. The exposure pathways for ecological receptors to contaminants in each of the exposure media are discussed separately in the following subsections.

4.1.4.1 Suspended Soil and Dust

For ecological receptors, exposures to suspended soil and dust can occur via inhalation. Wind erosion of soil can result in the suspension of dust and soil particles into the air which could be inhaled by receptors both on and off the RFT Site. The exposure pathways that are judged to be potentially complete include:

- Inhalation of soil/tailings by birds and mammals
- Inhalation of soil/tailings by amphibians and reptiles

Exposure to suspended soil or dust particles via inhalation is a potentially complete pathway but is generally considered insignificant for wildlife receptors (mammals and birds) in comparison to ingestion exposures. Although airborne soil particulates could be inhaled by wildlife receptor, it is more likely that these respirable particles (>5 um) will be ingested as a result of mucocilliary clearance (Witschi and Last, 1987). These exposures are considered to be quantified through the incidental soil ingestion pathway. For amphibians and reptiles inhalation and ingestion exposures are possible but there is no data available on the toxicity of either inhaled or ingested contaminants to evaluate these pathways.

4.1.4.2 Surface Soil and Tailings

For ecological receptors, exposures to surface soil and tailings can occur via two pathways: direct contact and incidental ingestion. Direct contact with tailings or soil mixed with tailings could occur in areas where the soil cover is thin, where animals burrow through cover soils or where plant roots penetrate the soil cover layer. Terrestrial receptors typically will not intentionally ingest large quantities of soil, however, some incidental ingestion of soil and tailings along with food items does occur (especially in receptors that feed on plants and soil invertebrates). The exposure pathways that are judged to be potentially complete include:

- Direct contact with surface soil/tailings by birds and mammals
- Direct contact with surface soil/tailings by plants and soil invertebrates
- Incidental ingestion of surface soil/tailings by birds and mammals

Dermal exposure to surface soil/tailings is a potentially complete pathway wildlife receptors (mammals and birds) but is generally considered insignificant in comparison to ingestion exposures. For amphibians and reptiles, dermal exposures are possible but there is no data available on the toxicity of dermally applied contaminants to evaluate this pathway. The pathways that are quantitatively evaluated in the SERA are:

- Incidental ingestion of surface soil/tailings by birds and mammals
- Direct contact with surface soil/tailings by plants and soil invertebrates

Analytical data are currently available (see Section 3) for tailings, impoundment cover soils, off-impoundment soils, and background soils for the RFT Site.

4.1.4.3 Terrestrial Food Chain

Contaminants in soils can enter the terrestrial food chain if organisms (i.e.: soil invertebrates, plants and small mammals) take up or accumulate contaminants from soils into tissues, which are then consumed by wildlife receptors. The exposure pathways that are judged to be potentially complete include:

- Ingestion of terrestrial food items by birds and mammals
- Ingestion of terrestrial food items by reptiles

For amphibians and reptiles ingestion exposures to contaminants in the terrestrial food chain are possible but there is no data available on the toxicity of ingested contaminants to evaluate this pathway. The pathways that are quantitatively evaluated in the SERA are:

- Ingestion of terrestrial food items by birds and mammals

Because tissue concentrations are not available for terrestrial food items such as plants, terrestrial or soil invertebrates, or wildlife species, soil concentrations for the RFT Site are used to estimate concentrations in these food items. Use of estimated tissue data rather than measured data is a source of uncertainty in the SERA. This uncertainty is discussed in Section 8 and the lack of terrestrial food chain data is further discussed as a possible data gap in Section 9.

4.1.4.4 Surface Water

Contaminants in surface water may result from the discharge of contaminated groundwater, runoff from the surface soils and tailings, disassociation of contaminants from sediments into surface water and the discharge of contamination from seeps. The exposure pathways that are judged to be potentially complete for contaminants in surface water include:

- Ingestion of surface water by aquatic receptors
- Ingestion of surface water by birds and mammals
- Ingestion of surface water by amphibians and reptiles

- Direct contact with surface water by aquatic receptors
- Direct contact with surface water by birds and mammals
- Direct contact with surface water by amphibians and reptiles

Exposures to contaminants in surface water by ingestion is potentially complete for amphibians, reptiles and aquatic receptors (invertebrates and fish). Data, however, are not available to either estimate toxicity or exposures related to the ingestion pathway for these receptors. Exposures for wildlife receptors (birds and mammals) to contaminants in surface water by dermal contact is potentially complete, but is generally considered insignificant in comparison to ingestion exposures. Exposures to contaminants in surface water by dermal contact is potentially complete for reptiles. Data, however, are not available to either estimate toxicity or exposure for this exposure pathway. The remaining pathways for surface water that are quantitatively evaluated in the SERA are:

- Ingestion of surface water by birds and mammals
- Direct contact with surface water by amphibians
- Direct contact with surface water by aquatic receptors

Analytical data are currently available for surface water for the RFT Site (see Section 3). These data are divided into several surface water exposure locations (units). These include the north and south diversion ditches, the unnamed drainages that flow into the south diversion ditch, ponded water areas, the wetlands area, and Silver Creek.

4.1.4.5 Sediment

Contaminants in sediment may result from the discharge of contaminated groundwater, runoff and erosion from surface soils and tailings, disassociation of contaminants from surface water into sediments and the discharge of contamination from seeps. The exposure pathways that are potentially complete for contaminants in sediment include:

- Incidental ingestion of sediment by aquatic receptors
- Incidental ingestion of sediment by birds and mammals
- Incidental ingestion of sediment by amphibians and reptiles

- Direct contact with sediment by benthic invertebrates
- Direct contact with sediment by birds and mammals
- Direct contact with sediment by amphibians

Exposures to contaminants in sediment by ingestion are potentially complete for amphibians, reptiles and aquatic invertebrates. Data, however, are not available to either estimate toxicity or exposures related to the ingestion pathway for these receptors. Exposures for wildlife receptors (birds and mammals) to contaminants in sediment by dermal contact is potentially complete but is generally considered insignificant in comparison to ingestion exposures. Exposures to contaminants in sediment by dermal contact is potentially complete for reptiles and amphibians. Data, however, are not available to either estimate toxicity or exposure for this exposure pathway. The remaining pathways for surface water that are quantitatively evaluated in the SERA are:

- Incidental ingestion of sediment by birds and mammals
- Direct contact with sediment by benthic invertebrates

Analytical data are currently available for sediment for the RFT Site (see Section 3). These data are divided into several sediment exposure locations that correspond to surface water exposure areas. These include the north and south diversion ditches, the unnamed drainages that flow into the south diversion ditch, ponded water areas, the wetlands area, and Silver Creek.

4.1.4.6 Aquatic Food Chain

Contaminants in surface water and sediment can enter the aquatic food chain if organisms (i.e.: benthic macroinvertebrates, fish, etc.) take up or accumulate contaminants from these media into tissues, which are then consumed by aquatic or wildlife receptors. The exposure pathways that are potentially complete include:

- Ingestion of aquatic food items by birds and mammals
- Ingestion of aquatic food items by aquatic receptors
- Ingestion of aquatic food items by amphibians and reptiles

For amphibians and reptiles ingestion exposures to contaminants in the aquatic food chain are possible but there are no data available on the toxicity of ingested contaminants to evaluate this pathway for these receptors. It is possible to evaluate ingestion exposures for fish to metals in food and sediment. The exposures however are expected to be insignificant compared to direct contact exposures. This exposure pathway will, however, be re-evaluated in the baseline risk assessment as more data becomes available on specific receptors present at the RFT Site. Risks associated with body burdens of contaminants in aquatic organisms (fish) will also be evaluated in the baseline risk assessment if fish tissue residue data becomes available. The pathways that are quantitatively evaluated in the SERA for the aquatic food chain are:

- Ingestion of aquatic food items by birds and mammals

Because tissue concentrations are not available for aquatic food items such as benthic macroivertebrates or fish, sediment concentrations for the RFT Site are used to estimate concentrations in these food items as appropriate. Use of estimated tissue data rather than measured data is a source of uncertainty in the screening assessment; this uncertainty is discussed in Section 8. The lack of aquatic food chain data is further discussed in the data gaps analysis as Section 9.

4.1.4.7 Seeps

To alleviate water pressure at the impoundment, the containment system is constructed to allow water to seep from the impoundment resulting in a seep area located at the toe of the main embankment. Although the flow from the seep is intermittent and low and does not reach Silver Creek via overland flow, it does impact the water chemistry in the wetlands area and it is still a potential exposure location for both aquatic and terrestrial receptors. The exposure pathways to seeps that are potentially complete include:

- Ingestion of seep water by aquatic receptors
- Ingestion of seep water by birds and mammals
- Ingestion of seep water by amphibians and reptiles

- Direct contact with seep water by aquatic receptors
- Direct contact with seep water by birds and mammals
- Direct contact with seep water by amphibians
- Direct contact with seep water by plants

Exposures to contaminants in seep water by ingestion is potentially complete for amphibians, reptiles and aquatic receptors (invertebrates and fish). Data, however, are not available to either estimate toxicity or exposures related to the ingestion pathway for these receptors. Exposures for wildlife receptors (birds and mammals) to contaminants in seep water by dermal contact is potentially complete, but is generally considered insignificant in comparison to ingestion exposures. Exposures to contaminants in seep water by dermal contact is potentially complete for reptiles. Data, however, are not available to either estimate toxicity or exposure for this exposure pathway. The remaining pathways for surface water that are quantitatively evaluated in the SERA are:

- Ingestion of seep water by birds and mammals
- Direct contact with seep water by amphibians
- Direct contact with seep water by aquatic receptors
- Direct contact with seep water by plants

Analytical data from the seep near the main embankment is not currently available. However, it is assumed that seep concentrations are similar to groundwater concentrations measured in wells at the base of the main embankment near the seep.

4.1.5 Changes to Previously Presented Model

The ecological site conceptual model presented as Figure 4-1 is based on site conceptual models presented in the Remedial Investigation SAP (RMC, 2001a - Figures 8a and 8b) with the following additions and changes:

- Separate models were previously presented for on-impoundment and off-impoundment areas. As the exposure pathways and receptors are similar on-impoundment versus off-impoundment these two models were collapsed into one.

- Separate models were previously presented for "upland" versus "wetland" areas. These two areas are still considered in the current model but are not specifically mentioned. It was necessary to elucidate exposure pathways for terrestrial wildlife to both soils in wetland and upland areas as well as surface water and sediments of wetland and stream habitats.

- Potential exposures to receptors to groundwater discharged as seep water and discharged to surface water was added to the ecological site conceptual model.

- The previous models differentiated "potentially significant" pathways from "potential" pathways. The current model identifies both as "potential" pathways. Those "potential" pathways that can be quantified are evaluated in the SERA.

4.2 Selection of Contaminants of Potential Concern

Contaminants of Potential Concern (COPCs) are contaminants which exist in the environment at concentrations that might be of potential concern to ecological receptors, and which are derived, at least in part, from site-related sources. Exposure pathways and media of concern for ecological receptors are identified and presented in the SCM (Figure 4-1). These exposure pathways and media of concern provide the assumptions for evaluating the appropriate media and receptors in the SERA. The purpose of the COPC selection procedure is to eliminate contaminants that are clearly not of potential ecological concern, and to carry forward those contaminants that might be of concern. The principal steps in eliminating or retaining a contaminant as an ecological COPC are described in Section 4.2.1 and are depicted in Figure 4-3. The results of the screening process are described in Section 4.2.2.

4.2.1 Screening Steps

4.2.1.1 Eliminate Contaminants Never Detected

In accord with USEPA (1989), a contaminant is a candidate for elimination from the quantitative risk assessment if it is detected infrequently or if there is no reason to believe that the contaminant may be present (i.e., when a contaminant is not site-related). Using this logic, a contaminant never detected in a media is eliminated from the quantitative risk assessment.

For contaminants that have never been detected, it is important to evaluate the adequacy of the detection limits for the available data. If the maximum detection limit for a contaminant is above available toxicity benchmarks, it should be evaluated qualitatively and identified as a source of uncertainty. It is assumed that these contaminants would only have a negligible effect on risk levels and would not likely result in a significant underestimate of risk.

4.2.1.2 Retain Contaminants Detected that are Bioaccumulative

Contaminants considered to be bioaccumulative are retained as COPCs if they are detected regardless of frequency of detection. Bioaccumulative contaminants of concern (BCCs) are defined as part of the Great Lakes Water Quality Guidance (GLWQG) wildlife Tier I criteria. There are 22 listed BCCs, of which one contaminant --mercury-- is detected at the RFT Site. Therefore, mercury is retained as a COPC. There are no other detected contaminants that are defined as bioaccumulative.

4.2.1.3 Eliminate Contaminants Detected Infrequently

In accord with USEPA (1989), a contaminant is a candidate for elimination from the quantitative risk assessment if it is detected infrequently. If a contaminant is detected infrequently (detection frequency is less than five percent), the contaminant is considered to be of little concern, but is evaluated qualitatively and identified as a source of uncertainty.

4.2.1.4 Eliminate Contaminants that are Considered to be Physiological Electrolytes

Several of the analytes measured in environmental media are considered to be essential physiological electrolytes for birds, mammals, plants and/or soil invertebrates. These analytes are eliminated as COPCs and include calcium, iron, magnesium, potassium, and sodium. Physiological electrolytes are not carried forward in the SERA.

4.2.1.5 Eliminate Contaminants Detected at Concentrations less than Background

This step involves comparing site contaminant concentrations to reference or background concentrations. Background for the purposes of the SERA are upgradient (upstream) concentrations of metals; those concentrations that do not represent contamination from the site. It is important to note that these samples are representative of anthropogenic, non-site related levels, they do not represent "pristine" (not influenced by human activity) environmental levels. In instances where the number of samples (N) is less than five, the reference data set is considered to be too small and a reference comparison is not made.

For the RFT Site, soil background samples were collected from eleven areas surrounding the site identified as not affected by wind-blown tailings. However, most (9 of 11) samples were only analyzed for arsenic and lead, and only two samples were analyzed for all RCRA metals. In addition, although sampling locations were selected from areas thought not to be affected by tailings, sampling location BG11 was later found to have been inadvertently placed near tailings. Because of the limited number of samples, limited number of analytes and the uncertainty in the representativeness of the data as "background", the background comparison screening step is not included as part of the COPC screening process for the SERA.

4.2.1.6 Eliminate Contaminants with Maximum Concentrations less than an Established Level of Concern

This step involves comparing the maximum detected contaminant concentration in an exposure medium to an appropriate ecologically-based screening level. If the maximum detected value is less than the screening level, the contaminant does not pose a potential risk and is eliminated as a COPC. If no ecologically-based screening level is available, the constituent is retained as a COPC. Separate screening processes are completed for aquatic and terrestrial receptors, resulting in two separate lists of COPCs.

COPC Selection Process for Aquatic Receptors. Surface water screening benchmarks for aquatic receptors are based on chronic ambient water quality criteria (AWQC) for both dissolved and total recoverable metals. AWQC values are derived from data for a wide range of aquatic species, and are intended to protect at least 95% of aquatic receptor (benthic invertebrate, plant, and fish) species from unacceptable adverse effects. Sediment screening benchmarks for benthic invertebrates are identified from Ingersoll et al. (1996) and Long and Morgan (1991). Screening benchmarks for surface water and sediment are listed in Table 4-2.

COPC Selection Process for Terrestrial Wildlife. Terrestrial wildlife screening benchmarks were identified from Sample et al. (1996), Pedigo et al. (1988), and Skorupa (1998). These benchmarks represent contaminant concentrations in drinking water and diet that are not expected to be associated with adverse effects to wildlife species. The screening benchmarks derived by Sample et al. (1996) are presented for 20 wildlife species. The lowest benchmark concentrations were selected for use in the screening process. Drinking water benchmarks were used to screen surface water data, while the dietary benchmarks were used to screen sediment and soil data. The use of the dietary benchmarks for sediment and soil screening is conservative, as the rate of incidental ingestion by wildlife is expected to be much lower than that for the diet. These screening benchmarks are summarized in Table 4-3.

4.2.2 Application of COPC Selection Methodology

4.2.2.1 Surface Water

The available surface water data are discussed in Section 3. The surface water data set includes samples from the south diversion ditch, the unnamed drainages that flow into the south diversion ditch, ponded water areas, and Silver Creek (Figure 2-1). Tables 4-4 and 4-5 summarize the COPC selection for surface water at the RFT Site for aquatic and terrestrial receptors, respectively. As seen, the left side of each table lists for each of the analytes: the number of detections, the number of samples, the detection frequency, and the mean and maximum concentrations for non-detects and detects.

COPCs for Aquatic Receptors. The results of the surface water COPC selection process for aquatic receptors are summarized in Table 4-4 for dissolved and total recoverable metals. Seventeen contaminants are identified as COPCs in surface water for aquatic receptors including aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, cyanide, lead, manganese, mercury, selenium, silver and zinc. Potential risks for aquatic receptors associated with these COPCs are evaluated further in the risk characterization sections of this SERA.

COPCs for Terrestrial Receptors. Table 4-5 provides the results of the surface water COPC selection process for terrestrial receptors. Six contaminants are identified as COPCs in surface water for terrestrial wildlife receptors: arsenic, lead, mercury, selenium, silver and zinc. Potential risks for this COPC are evaluated further in the risk characterization sections of this SERA.

4.2.2.2 Sediment

The available sediment data are discussed in Section 3. The sediment data set includes samples from the south diversion ditch, the wetland area, and Silver Creek (Figure 2-1). Tables 4-6 and 4-7 summarize the COPC selection for sediments at the RFT Site for aquatic and terrestrial receptors, respectively. As seen, the left side of each table lists for each of the analytes: the number of detections, the number of samples, the detection frequency, and the mean and maximum concentrations for non-detects and detects.

COPCs for Benthic Invertebrates. The results of the sediment COPC selection process for benthic invertebrates are summarized in Table 4-6. Eighteen contaminants are identified as COPCs in sediment for aquatic receptors, including aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, and zinc. Potential risks for these COPCs are evaluated further in the risk characterization sections of this SERA.

<u>COPCs for Terrestrial Receptors.</u> Table 4-7 provides the results of the sediment COPC screen for terrestrial receptors. Seventeen contaminants are identified as COPCs in sediment for terrestrial wildlife receptors, including aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, and zinc. Potential risks for these COPCs are evaluated further in the risk characterization sections of this SERA.

<u>4.2.2.3 Soils and Tailings</u>

The available data sets for tailings and soils are discussed in Section 3. Site tailings, cover soils (both on and off the impoundment), and the background soils were combined into one data set for the purposes of the COPC screen. Table 4-8 summarizes the COPC selection for soils and tailings at the RFT Site for terrestrial receptors. As seen, the left side of the table lists for each of the analytes: the number of detections, the number of samples, the detection frequency, and the mean and maximum concentrations for non-detects and detects.

<u>COPCs for Terrestrial Receptors.</u> Table 4-8 provides the results of the soils and tailings COPC screen for terrestrial receptors. Twelve contaminants are identified as COPCs in soils and tailings for terrestrial wildlife receptors, including aluminum, antimony, arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, silver, and zinc. Potential risks for these COPCs are evaluated further in the risk characterization sections of this SERA.

4.2.3 Summary

The exposure pathways selected for quantitative evaluation in the SERA including the following:

Aquatic Receptors

- Direct contact with surface water and seep water for fish and benthic invertebrates
- Direct contact with sediments by benthic invertebrates

Amphibians

- Direct contact with surface water and seep water

Birds & Mammals

- Ingestion of surface water and seep water
- Ingestion of terrestrial and aquatic food items
- Incidental ingestion of sediment and soil and/or tailings

Terrestrial Plants & Soil Fauna

- Direct contact with soil and/or tailings
- Direct contact with seep water

The COPCs selected for each of these exposure pathways and media of concern based on the SCM (Figure 4-1) are summarized in the following text table:

Summary of COPCs Selected for Evaluation in the SERA					
Analyte	Surface Water		Sediment		Soil & Tailings
	Aquatic Receptors	Terrestrial Receptors	Aquatic Receptors	Terrestrial Receptors	Terrestrial Receptors
Aluminum	X		X	X	X
Antimony	X		X	X	X
Arsenic	X	X	X	X	X
Barium	X		X	X	X
Beryllium	X		X		
Boron	X				
Cadmium	X		X	X	X
Chromium	X		X	X	X
Cobalt	X		X	X	
Copper	X		X	X	X
Cyanide	X				
Lead	X	X	X	X	X
Manganese	X		X	X	
Mercury	X	X	X	X	X
Nickel			X	X	
Selenium	X	X	X	X	X
Silver	X	X	X	X	X
Thallium			X	X	
Vanadium			X	X	
Zinc	X	X	X	X	X
Total COPCs	*17*	*6*	*18*	*17*	*12*

4.3 Identification of Assessment and Measurement Endpoints

4.3.1 Identified Goals for the Screening Ecological Risk Assessment

The overall management goal for ecological health at the RFT Site is stated as the following:

> *Ensure adequate protection of ecological systems within the impacted areas of the Richardson Flat Tailings Site by protecting them from the deleterious effects of acute and chronic exposures to site-related contaminants of concern.*

In order to provide specificity regarding this general goal and identify specific measurable ecological values to be protected, the following list of sub-goals was derived:

- Ensure adequate protection of terrestrial soil fauna and plant communities, including native plant communities, by protecting them from the deleterious effects of acute and chronic exposures to site-related contaminants of concern.

- Ensure adequate protection of aquatic and amphibian life in Silver Creek, the site diversion ditches and wetlands areas from the deleterious effects of acute and chronic exposures to site-related contaminants of concern.

- Ensure adequate protection of terrestrial mammal and bird populations by protecting them from the deleterious effects of acute and chronic exposures to site-related contaminants of concern.

- Ensure adequate protection of threatened and endangered species (including candidate species) and species of special concern and their habitat by protecting them from the deleterious effects of acute and chronic exposures to site-related contaminants of concern.

  (Note: "Adequate" protection is generally defined as protective of growth, reproduction, and survival of local populations.)

4.3.2 Identification of Assessment and Measurement Endpoints

Assessment endpoints are explicit statements of the characteristics of the ecological system that are to be protected. Assessment endpoints are either measured directly or are evaluated through indirect measures. Measurement endpoints represent quantifiable ecological characteristics that can be measured, interpreted, and related to the valued ecological components chosen as the assessment endpoints (USEPA, 1992; 1997).

The following assessment and measurement endpoints are used to interpret potential ecological risks for the RFT Site for the SERA. In some cases, more than one measurement endpoint is identified for a particular assessment endpoint. These instances permit a weight-of-evidence approach to be used in risk characterization. In other cases, a measurement endpoint may be relevant to more than one assessment endpoint.

Assessment Endpoint	Measurement Endpoint
Protection of terrestrial plants and soil fauna from adverse effects related to exposure to COPCs in surface soil.	Comparison of COPC concentrations in soil to terrestrial toxicity benchmarks.
Protection of benthic invertebrates, fish and amphibians from adverse effects related to exposure to COPCs in surface water and sediment.	Comparison of sampling location-specific COPC concentrations in surface water and sediment to aquatic toxicity benchmarks.
Protection of terrestrial wildlife from adverse effects to growth, reproduction or survival related to exposure to COPCs in surface water, sediment, soil, and food items.	Comparison of the predicted average daily doses of COPCs from surface water, sediment, and food to toxicity reference values.

5.0 SCREENING LEVEL EXPOSURE ASSESSMENT

5.1 Aquatic Receptors

5.1.1 Surface Water

Aquatic receptors (benthic invertebrates, plants, fish and amphibians) are potentially exposed to COPCs in surface water via direct contact. The exposure point concentration (EPC) for aquatic receptors to COPCs in surface water is either the 95th upper confidence limit (95UCL) of the mean or the maximum concentration, whichever is lower. For some locations, limited samples are available; at these locations the EPC is usually equal to the maximum measured concentration. COPCs that are non-detects (U qualified; below the detection limit) are evaluated at one-half the reported detection limit in the calculation of the EPC. For the purposes of the SERA, direct contact exposures with surface water are evaluated on a sampling location-specific basis. The location specific EPCs for each COPC by sampling location are listed in Table 5-1. These EPCs are compared to toxicity benchmarks identified in Section 6.1.1 for benthic invertebrates and fish and Section 6.2 for amphibians to identify potential risks for each, respectively in Section 7.1.1 and 7.2.1.

5.1.2 Sediment

Benthic invertebrates are potentially exposed to COPCs in sediment via direct contact. The EPC for benthic invertebrates to COPCs in sediments is either the 95th upper confidence limit (95UCL) of the mean or the maximum concentration, whichever is lower. For some locations, only one or a limited number of samples are available; therefore the EPC is usually equal to the maximum measured concentration. COPCs that are non-detects (U qualified; below the detection limit) are evaluated at one-half the reported detection limit in the calculation of the EPC. For the purposes of the SERA, direct contact exposures with sediment are evaluated on a sampling location-specific basis. The location specific EPCs for sediment for each COPC by sampling location are listed in Table 5-2. These EPCs are compared to toxicity benchmarks identified in Section 6.1.2 to identify potential risks for aquatic receptors in Section 7.1.1.2.

5.1.3 Seeps

Benthic invertebrates and amphibians are potentially exposed to COPCs in seep water via direct contact. The EPC for benthic invertebrates and amphibians to COPCs in seep water is either the 95th upper confidence limit (95UCL) of the mean or the maximum concentration, whichever is lower. COPCs that are non-detects (U qualified; below the detection limit) are evaluated at one-half the reported detection limit in the calculation of the EPC. For the purposes of the SERA, direct contact exposures with seep water are evaluated for each monitoring well (groundwater data used to estimate seep concentrations). The EPCs for each COPC by monitoring well are listed in Table 5-3. These EPCs are compared to toxicity benchmarks identified in Section 6.1.1 for benthic invertebrates and fish and Section 6.2 for amphibians to identify potential risks for each, respectively in Section 7.1.3 and 7.2.2 .

5.2 Terrestrial Plants and Soil Fauna

5.2.1 Soils

Terrestrial plants and soil invertebrates are potentially exposed to COPCs in soils via direct contact. Exposures for these receptors are evaluated on a sampling location-specific basis. The EPC for plants and soil invertebrates is equal to the average concentration across all depths at each sampling location for each COPC. The EPCs are listed for each soil sampling location in Appendix F. The EPC for each COPC for each sampling location is compared to toxicity benchmarks for terrestrial plants and soil invertebrates presented in Sections 6.3 and 6.4, respectively, to identify potential risks for these receptors from direct contact with COPCs in soil in Sections 7.3 and 7.4.

5.2.2 Seeps

Terrestrial plants are potentially exposed to COPCs in seeps via direct contact. Exposures are evaluated for each monitoring well used to estimate seep water concentrations. The EPC for each COPC in seep water (groundwater) is equal to the 95th upper confidence limit (95UCL) of the mean or the maximum concentration, whichever is lower. COPCs that are non-detects (U qualified; below the detection limit) are evaluated at one-half the reported detection limit in the calculation of the EPC. The EPCs are listed for each groundwater well in Table 5-3. The EPC for each COPC for each sampling location is compared to aqueous toxicity benchmarks for terrestrial plants in Sections 6.3.2 to identify potential risks for plants exposed to COPCs in seep water in 7.3.2.

5.3 Wildlife

Wildlife species may be exposed to COPCs by ingestion of surface water, seep water, sediments,, soils and food items that have taken up contaminants into their tissues. Exposures for wildlife receptors to each environmental medium of concern are assessed for five exposure areas at the RFT Site (Figure 2-1) including:

- Upstream Silver Creek,
- Downstream Silver Creek,
- The south diversion ditch,
- Ponded water areas on the impoundment, and
- Unnamed drainages which flow into the south diversion ditch.

The following subsections describe how wildlife species are selected for evaluation and how COPC exposure doses are estimated for wildlife for each exposure medium for each exposure area.

5.3.1 Identification of Representative Wildlife Species

It is not feasible to evaluate exposures and risks for each avian and mammalian species potentially present within the study area. For this reason, specific wildlife species are identified as representative wildlife species for the purpose of estimating quantitative exposures (doses) in the SERA. The representative species are wildlife species that are potentially present within the Site area and are representative of other species with similar dietary preferences and feeding guilds. Selection criteria for representative wildlife species includes trophic level, feeding habits, and the availability of life history information. Representative wildlife receptors selected for the RFT Site are summarized in the following text table.

Summary of Representative Wildlife Receptors		
Type	**Species**	**Represents**
Small Mammalian Omnivores	Deer Mouse (*Peromyscus maniculatus*)	Small mammalian terrestrial omnivore receptors ingesting terrestrial food items (vegetation & terrestrial invertebrates), soil, and surface water.
Small Mammalian Insectivores	Masked Shrew (*Sorex cinereus*)	Small mammalian terrestrial insectivore receptors ingesting terrestrial food items (soil invertebrates), soil, and surface water.
Mammalian Carnivores	Red Fox (*Vulpes vulpes*)	Mammalian carnivore receptors ingesting terrestrial food items (small mammals), soil, and surface water.
Mammalian Piscivores	Mink (*Mustela vison*)	Mammalian piscivore receptors ingesting aquatic food items (fish), sediment, and surface water.
Small Avian Insectivores	Mallard Duck (*Anas platyrhynchos*)	Avian insectivore receptors ingesting aquatic food items (benthic invertebrates), sediment, and surface water.
Small Avian Herbivores	Greater-Sage Grouse (*Centrocercus urophasianus*)	Small avian terrestrial herbivore receptors ingesting terrestrial food items (vegetation), soil, and surface water.
Small Avian Omnivores	American Robin (*Turdus migratorius*)	Avian omnivore receptors ingesting terrestrial food items (vegetation & soil invertebrates), soil, and surface water.
Avian Carnivores	American Kestrel (*Falco sparverius*)	Avian carnivore receptors ingesting terrestrial food items (small mammals), soil, and surface water.
Avian Piscivores	Belted Kingfisher (*Ceryle alcyon*)	Avian piscivore receptors ingesting aquatic food items (fish), sediment, and surface water.

NO

Some species-specific factors are needed to estimate doses of COPCs including body weight, ingestion rates, and dietary composition. These wildlife exposure factors are derived largely from the Wildlife Exposure Factors Handbook (USEPA, 1993a and b). The exposure factors including derivation and sources are provided as Appendix B. A summary of the exposure factors selected for the selected wildlife receptors is provided in Table 5-4.

5.3.2 Estimation of Doses Associated with Ingestion of Surface Water or Seep Water

Exposures to COPCs in surface water are quantified based on the following equation:

$$Dose_{sw} = \frac{IR_{sw} x C_{sw}}{BW} x AUF$$

where:

IR_{sw}	=	Ingestion rate of surface water or seep water for the receptor of interest (L/day);
C_{sw}	=	Concentration of COPC in sediment (mg/L);
AUF	=	Area Use Factor; and
BW	=	Body weight of the receptor of interest (kg wet weight).

C_{sw} is equal to the EPC of each COPC for surface water within each exposure area. The EPC is equal to either the 95th upper confidence limit (95UCL) of the mean or the maximum concentration, whichever is lower. COPCs that are non-detects (U qualified; below the detection limit) are evaluated at one-half the reported detection limit in the calculation of the EPC. The surface water EPC concentrations for each COPC by exposure area are listed in Table 5-5. These EPC concentrations are compared to toxicity reference values (TRVs) calculated for wildlife in Section 6.5 to estimate risks for wildlife for ingestion of COPCs in surface water in Section 7.5.1 and seep water in Section 7.5.3. The AUF for each wildlife species is conservatively assumed to be 100%.

5.3.3 Estimation of Doses Associated with Ingestion of Sediments

Exposures to COPCs in sediment are quantified based on the following equation:

$$Dose_{sed} = \frac{IR_{sed} x C_{sed}}{BW} x AUF$$

where:

IR_{sed}	=	Ingestion rate of sediment for the receptor of interest (kg dry weight/day);
C_{sed}	=	Concentration of COPC in sediment (mg/kg dry weight);
AUF	=	Area Use Factor; and
BW	=	Body weight of the receptor of interest (kg wet weight).

C_{sed} is equal to the EPC for each COPC for sediment within each exposure area. The EPC is equal to either the 95th upper confidence limit (95UCL) of the mean or the maximum concentration, whichever is lower. COPCs that are non-detects (U qualified; below the detection limit) are evaluated at one-half the reported detection limit in the calculation of the EPC. The sediment EPC concentrations for each COPC by exposure area are listed in Table 5-6. These EPC concentrations are compared to toxicity reference values (TRVs) calculated for wildlife in Section 6.5 to estimate risks for wildlife for ingestion of COPCs in sediment in Section 7.5.2. The AUF for each wildlife species is conservatively assumed to be 100%.

5.3.4 Estimation of Doses Associated with Ingestion of Soils/Tailings

Exposures to COPCs in soil/tailings are quantified based on the following equation:

$$Dose_{sed} = \frac{IR_{sed} x C_{sed}}{BW} x AUF$$

where:

IR_{soil}	=	Ingestion rate of soil for the receptor of interest (kg dry weight/day);
C_{soil}	=	Concentration of COPC in soil (mg/kg dry weight);
AUF	=	Area Use Factor; and
BW	=	Body weight of the receptor of interest (kg wet weight).

C_{soil} is equal to the EPC of each COPC for soil/tailings at each exposure area. The AUF for each wildlife species is conservatively assumed to be 100%. The estimated doses for exposure to COPCs in soil/tailings are calculated for each representative wildlife species and presented in Section 6. The estimated doses are compared to dietary ingestion TRVs in Section 6.2 to characterize risks.

C_{sed} is equal to the EPC for each COPC for soil within each exposure area. The EPC is equal to either the 95th upper confidence limit (95UCL) of the mean or the maximum concentration, whichever is lower. COPCs that are non-detects (U qualified; below the detection limit) are evaluated at one-half the reported detection limit in the calculation of the EPC. The soil EPC concentrations for wildlife for each COPC by exposure area are listed in Table 5-7. These EPC concentrations are compared to toxicity reference values (TRVs) calculated for wildlife in Section 6.5 to estimate risks for wildlife for ingestion of COPCs in soil in Section 7.5.4. The AUF for each wildlife species is conservatively assumed to be 100%.

5.3.5 Estimation of Doses Associated with Ingestion of Food Items

Dietary exposures are possible for terrestrial wildlife by ingestion of terrestrial food chain items (soil invertebrates, plants, birds and mammals) and/or ingestion of aquatic food chain items (plants, benthic invertebrates, and fish). For the SERA, five food types are included in the wildlife exposure model including aquatic invertebrates, fish, terrestrial vegetation, soil invertebrates and small mammals.

The dietary intake of a COPC for each representative species is estimated by the following equation:

$$Dose_{diet} = \frac{IR_{food} \times \sum(C_{food_i} \times df_i)}{BW}$$

IR_{food}	=	Ingestion rate of food for the receptor of interest (kg dry weight/day);

C_{foodi} = Concentration of COPC in food type "i" (aquatic invertebrate, fish, plant or soil invertebrate) (mg/kg wet weight);
df_i = Dietary fraction (proportion in the diet) of food type "i" (unitless) for the receptor of interest;
BW = Body weight for the receptor of interest (kilograms).

For the SERA, measured biological tissue data is not available; therefore, the calculation of dietary exposure concentrations and doses for wildlife receptors is based on estimated tissue concentrations using bioaccumulation factors (BAFs) for each COPC for each media of concern. C_{food} is equal to the estimated concentration of each COPC in biota within each exposure area. The estimated concentrations of COPCs in food items are based on the EPC concentrations in the respective environmental media (surface water, sediment or soil). The EPC concentrations in food items are listed in Table 5-8. The following subsections describe how concentrations of COPCs in food items are estimated and doses for wildlife calculated for each food item.

5.3.5.1 Benthic Invertebrates and Fish

In order to evaluate food chain exposures for terrestrial wildlife consuming aquatic receptors (benthic invertebrates and fish) at the RFT Site it is necessary to estimate tissue concentrations. Metal tissue concentrations in benthic invertebrates are estimated using equations that estimate the bioaccumulation of inorganic elements into freshwater invertebrate tissues from sediment. These biota-sediment accumulation factors (BSAFs) focus primarily on invertebrates with terrestrial adult stages (i.e.: mayflies) or are prey items for fish (i.e.: amphipods, tubificid worms) and are intended for use in screening level ecological risk assessments to determine the need for further evaluation (BJC, 1998). Based on the model recommendations, the 90th percentile BSAF based on both depurated and non-depurated organisms is used to derive benthic tissue concentrations from sediment.

Parameter	90th Percentile BSAF
Arsenic	0.69
Cadmium	41.55
Chromium	0.468
Cobalt	5.25
Copper	23.87
Lead	0.607
Mercury	2.868
Nickel	2.32
Zinc	7.527

[conc in benthic dw] = BSAF * [conc in sediment dw]

Estimated tissue concentrations in benthic invertebrates, based on sediment EPC concentrations, are calculated for each exposure area in Appendix C. A summary of these concentrations are provided in Table 5-8. These concentrations are used to estimate doses for wildlife consuming benthic invertebrates.

The doses are provided in Appendix C. The doses are compared to TRVs from Section 6.5 to characterize risks for wildlife receptors from the ingestion of benthic invertebrates in Section 7.5.5.1.

Metal tissue concentrations in fish tissue are assumed, conservatively, to be equal to sediment concentrations. This is assumed to represent both uptake from surface water and sediments. The actual extent of bioaccumulation of metals from surface water and sediments into fish tissue is dependant on multiple site-specific factors that are difficult to model.

Estimated tissue concentrations in fish, based on sediment EPC concentrations are calculated for each exposure area in Appendix C. A summary of these concentrations are provided as Table 5-8. These concentrations are used to estimate doses for wildlife consuming fish. The doses are provided in Appendix C. The doses are compared to TRVs from Section 6.5 to characterize risks for wildlife consuming fish in Section 7.5.5.2.

5.3.5.2 Terrestrial Plants

In order to evaluate food chain exposures for wildlife consuming terrestrial plants, plant tissue concentrations are estimated for each exposure area using equations that estimate the bioaccumulation of inorganic elements into terrestrial plant tissues based on soil concentrations. Bechtel Jacobs Company (BJC) (1998) reviewed available literature for collocated soil and plant data to derive empirical models for the uptake of metals from soil to plants. BJC (1998) concluded that for ecological risk assessments, a single-variable regression model better estimates plant tissue concentrations from soil concentrations than use of a single uptake factor. For several inorganic elements (such as cadmium, mercury, selenium, and zinc), a multiple regression model that includes pH is preferred. Unfortunately, data regarding soil pH is not available at the RFT Site, therefore all plant tissue estimates are calculated using the single-variable regression model.

Parameter	B_0	B_1	R^2
Arsenic	-1.992	0.564	0.145
Cadmium	-0.476	0.546	0.447
Copper	0.669	0.394	0.314
Mercury	-0.996	0.544	0.598
Lead	-1.328	0.561	0.243
Selenium	-0.678	1.104	0.633
Zinc	1.575	0.555	0.402

$\ln(\text{plant}) = B_0 + B_1 * \ln(\text{soil})$

where all concentrations are expressed as mg/kg dw

Estimated tissue concentrations of COPCs in plants based on soil EPC concentrations are calculated in Appendix C. A summary of these concentrations are provided in Table 5-8. These concentrations are used to estimate doses for wildlife consuming plants. The doses are provided in Appendix C. These doses are compared to TRVs from Section 6.5 to characterize risks for wildlife receptors from the ingestion of plants in Section 7.5.5.3.

5.3.5.3 Terrestrial Invertebrates (Earthworms)

In order to evaluate food chain exposures from soil invertebrates, earthworm tissue concentrations are estimated for each exposure area using bioaccumulation models derived by Sample et al. (1998a). Sample et al. (1998a) developed a database of soil and earthworm tissue concentrations for several inorganic and organic chemicals based on 32 studies from 11 countries and 5 states. For almost all inorganic elements, a single-variable regression model provides the best estimates of earthworm tissue concentrations. For cadmium and lead, a multiple regression model including soil calcium improved the model fit. Measured data regarding soil calcium, however is not available for most soil samples collected at the RFT Site, therefore all earthworm tissue estimates are calculated using the single-variable regression model. No model is identified to accurately predict chromium or nickel concentrations in earthworm tissue.

Parameter	B_0	B_1	R^2
Arsenic	-1.421	0.706	0.26
Cadmium	2.114	0.795	0.67
Copper	1.675	0.264	0.18
Mercury [a]	0.0781	0.3369	0.51
Lead	-0.218	0.807	0.8
Selenium [b]	-0.075	0.733	0.43
Zinc	4.449	0.328	0.45

ln(earthworm) = $B_0 + B_1$ * ln(soil)
where all concentrations are expressed as mg/kg dw
[a] Based on model data only, validation data excluded
[b] Based on data set with outlier excluded

Tissues concentrations of COPCs in earthworms are estimated for each exposure area based on the EPC values for soil. The calculations are provided as Appendix C and the results are summarized in Table 5-8. These concentrations are used to calculate doses for wildlife species consuming soil invertebrates for each exposure area. These calculations are provided in Appendix C. The doses are compared to TRVs calculated in Section 6.5 to estimate risks for wildlife consuming soil invertebrates in Section 7.5.5.4.

5.3.5.4 Small Mammals

In order to evaluate food chain exposures for wildlife species consuming small mammals, tissue concentrations are estimated for each exposure area using bioaccumulation models derived by Sample et al. (1998b). Sample et al. (1998b) developed a database of soil and small tissue concentrations for 14 inorganic and 2 organic chemicals based on 20 different studies. Small mammal species are divided into 3 trophic feeding groups based on diet – herbivore, insectivore, and omnivore. If sufficient data were available for each trophic group (N>4), trophic-group-specific regression models were developed based on whole body tissue concentrations. If there was insufficient data or if trophic-group-specific models were not reliable, general regression models, which included all trophic group data were developed. For most inorganic elements, a single-variable regression model was used to estimate small mammal tissue concentrations. For barium and mercury in all trophic groups and for chromium and copper in herbivores, the estimated tissue concentration was based on the median uptake factor.

Parameter	Trophic Group	Equation used for Estimation	B_0	B_1	Median Uptake Factor	R^2
Arsenic	Insectivore	General	-4.8471	0.8188	--	0.52
	Herbivore	Trophic-group regression	-5.6531	1.1382	--	0.72
	Omnivore	Trophic-group regression	-4.5796	0.7354	--	0.41
Barium	All	Median general UF	–	–	0.0168	--
Cadmium	Insectivore	Trophic-group regression	0.815	0.9638	--	0.53
	Herbivore	Trophic-group regression	-1.2571	0.4723	--	0.64
	Omnivore	Trophic-group regression	-1.5383	0.566	--	0.63
Chromium	Insectivore & Omnivore	General	-1.4599	0.7338	--	0.42
	Herbivore	Median trophic group UF	–	–	0.0774	--
Copper	Insectivore	Trophic-group regression	2.1042	0.1783	--	83
	Herbivore	Median trophic group UF	–	–	0.0525	--
	Omnivore	Trophic-group regression	1.4592	0.2681	--	0.48
Mercury	All	Median general UF	–	–	0.0543	--
Lead	Insectivore	Trophic-group regression	0.4819	0.4869	--	0.53
	Herbivore	Trophic-group regression	-0.6114	0.5181	--	0.68
	Omnivore	General	0.0761	0.4422	--	0.37
Selenium	All	General	-0.4158	0.3764	--	0.31
Zinc	All	General	4.4713	0.0738	--	0.13

ln(small mammal) = $B_0 + B_1$ * ln(soil)
small mammal = median uptake factor * soil
where all concentrations are expressed as mg/kg dw

Tissue concentrations of each COPC for each exposure area are estimated based on the soil EPC values. The calculations are provided in Appendix C. A summary of the concentrations by exposure area are listed in Table 5-8. These concentrations are used to estimate doses for wildlife consuming small mammals. The calculations are provided in Appendix C. The doses are compared to TRV values calculated in Section 6.5 to estimate risks for wildlife consuming small mammals in Section 7.3.5.5.

6.0 SCREENING LEVEL EFFECTS ASSESSMENT

Potential risks for ecological receptors are estimated in the SERA based on the Hazard Quotient (HQ) approach. The exposure concentrations (or doses) identified in Section 5 are compared to respective toxicity screening benchmarks to calculate an HQ value. If the HQ is less than or equal to one, then no potential for adverse effects is expected. If the HQ exceeds one, adverse effects are possible. This section identifies the toxicity screening benchmarks for each receptor for each exposure medium.

6.1 Toxicity Benchmarks for Aquatic Receptors

6.1.1 Screening Benchmarks for Surface Water and Seeps

The USEPA has derived acute 24-hour and chronic 4-day Ambient Water Quality Criteria (AWQC) values for a number of metals in surface water, including each of the metals of potential ecological concern at the RFT Site (USEPA, 1985b-e; USEPA, 1987; USEPA, 1996; USEPA, 2001b). These AWQC values are based on thorough review of available toxicological information and toxicity testing on the effects of the metal on aquatic receptors (including benthic invertebrates, fish, and aquatic plants), and each criterion is intended to protect 95% of the aquatic genera for which toxicity data are available (USEPA, 1985a).

An important characteristic of AWQC values is that many (but not all) depend on the properties of the test water, especially hardness. Thus, the AWQC for many metals are not fixed values, but increase as hardness increases. The generic form of the equation used to calculate the AWQC (expressed in units of ug/L) at a given hardness H (expressed in units of mg/L) is as follows:

$$AWQC_{total} = \exp[a \times \ln(H) + b]$$

The parameters a and b are empirically-derived coefficients of the best fit straight line through the data in log space. That is:

$$\ln(AWQC_{total}) = a \times \ln(H) + b$$

In cases where the value of AWQC does not depend on hardness (e.g., arsenic), the value of 'a' is zero and the equation reduces to:

$$AWQC_{total} = \exp(b) = \text{Constant}$$

Originally, all AWQC are expressed in terms of total recoverable metal, and are used by comparison to the total recoverable metal concentrations measured in surface water at the site. Subsequently, the EPA concluded that dissolved metals (rather than total metals) are a better indicator of potential risks due to direct contact (e.g., gill respiration in fish) as this concentration represents the amount of the constituent that is biologically available (USEPA, 1995). As a result, the EPA has identified a method for adjusting the AWQC based on total metals which is suitable for use in evaluating risks from dissolved metals

(USEPA 1995). The general form of the equation used to adjust the criterion from total to dissolved is as follows:

$$AWQC_{dissolved} = AWQC_{total} \times \text{Conversion Factor}$$

$$\text{Conversion Factor} = m - n \times \ln(H)$$

The parameters m and n are empirically-derived coefficients of the equation relating total and dissolved concentrations of the metal in laboratory water.

In some cases the conversion factor does not depend on hardness (e.g., arsenic, copper, zinc), so the value of 'n' is zero and the equation reduces to:

$$\text{Conversion Factor} = m$$

However, evaluation of risks to receptors based only on dissolved metal levels could tend to underestimate the total risk across all exposure pathways, including direct contact with solids (either as sediment or suspended in the river) as well as ingestion of contaminated foods and sediments. Even though total recoverable metal levels in surface water may not correlate well with risks from direct contact exposure, use of this more conservative concentration value can help compensate for the omission of risks from other exposure pathways.

Table 6-1 summarizes the parameters (a, b, m, n) needed to calculate the acute and chronic default AWQC for total and dissolved metals of potential concern at the RFT Site and presents AWQC values for each metal at a hardness of 100 mg/L. Also presented are the specified hardness limits for derivation of the AWQC, if the measured station hardness is outside of the specified hardness limits, the applicable hardness limit is used to calculate the station-specific AWQC.

The aquatic benchmarks used to select COPCs in surface water in Section 4 are also AWQC values. In that instance, the chronic AWQC for both dissolved and total metals was compared the maximum detected concentration to identify a contaminant as a COPC. For the screening risk characterization, these comparisons are made for each surface water sampling station for both acute and chronic criteria. The results provide some insight on spatial trends of potential risks for aquatic life.

6.1.2 Screening Benchmarks for Sediment

Screening benchmarks for aquatic invertebrates for exposure to COPCs in sediment are identified based on a review of literature reporting sediment quality guidelines. Several sets of sediment quality guidelines are available. The National Oceanic and Atmospheric Administration (NOAA) compiled a set of Effects Range Low (ERL) and Effects Range Median (ERM) levels for contaminants in sediment (Long and Morgan, 1991). The Ontario Ministry of Environment has identified a set of Severe Effects Threshold (SET) values (Persaud et al., 1993). MacDonald et al. (1996) expanded on the work of Long and Morgan (1991) and developed a set of guidelines including threshold effects levels (TELs) and probable effects levels (PELs). These sediment quality guidelines are derived based on data primarily from marine environments.

Ingersoll et al. (1996) compiled freshwater sediment toxicity data from nine different sites in the United States and identified a series of sediment effect concentrations (SECs) for a series of metals in sediment. The SECs are defined as the concentrations of individual contaminants in sediment below which toxicity is rarely observed and above which toxicity is frequently observed. The database was compiled to classify toxicity data for Great Lakes sediment samples. Ingersoll et al.(1996) derived five different SECs according to the methodology of Long and Morgan (1990), Persaud et al. (1993) and MacDonald Environmental Sciences Ltd (1994). The SECs include an ERL, ERM, TEL, PEL and no effect concentration (NEC). Ingersoll et al (1996) calculated these freshwater ERL, ERM, TEL and PEL values using the same procedures as NOAA and MacDonald Environmental Sciences Ltd. (1994).

NOAA ERL and ERM Values. The NOAA ERL represents the 10th percentile of values sorted in ascending order reported to be associated with an adverse effect. The NOAA ERM is the median value in the ranking. An ERL is defined by Long and Morgan (1990) and Long et al. (1995) as the concentration of a chemical in sediment below which adverse effects are rarely observed or predicted among sensitive species. An ERM is defined by Ingersoll et al (1996) as the concentration of a chemical above, which effects are frequently or always observed or predicted among most species. The ERLs calculated by Ingersoll et al. (1996) use the 15th percentile.

State of Florida TEL and PEL Values. MacDonald Environmental Sciences Ltd .(1994) calculated TELs and PELs using an expanded database of Long and Morgan (1991). Freshwater data were excluded from the analyses. Sediment concentrations associated with an adverse effect were sorted in ascending order and an ERL (15th percentile) and ERM (50th percentile) were identified. The concentrations associated with no adverse effect were also sorted and a no effect range high (85th percentile) and no effect range median (50th percentile) were identified. The TEL is equal to the geometric mean of the ERL and no effect range median. The PEL is equal to the geometric mean of the ERM and the no effect range high. Although similar, the TEL and PEL values are lower than the ERL and ERM values. The values are lower because they are calculated using both "effect" and "no-effect" data; whereas, the ERL and ERM use only "effect" data. The NEC is the maximum concentration of a chemical in sediment that does not significantly adversely affect the particular response when compared to the control.

Consensus-Based Sediment Quality Guidelines (SQGs). In an effort to focus on agreement among the various sediment quality guidelines (previously discussed), MacDonald et al. (2000) issued consensus-based SQGs for 28 chemicals of concern. For each chemical of concern, a threshold effect concentration (TEC) and a probable effect concentration (PEC) were identified. The predictive reliability of these values was also evaluated. The criteria for establishing reliability of the consensus-based PECs was based on Long et al. (1998). This predictive ability analysis was focused on the ability of each SQG when applied alone to classify samples as either toxic or non-toxic. These criteria are intended to evaluate the narrative intent of the values. Sediment toxicity should be observed only rarely below the TEC and should be frequently observed above the PEC. Individual TECs were considered reliable if more than 75% of the sediment samples were correctly predicted to be non-toxic. Similarly, the individual PEC was considered reliable if greater than 75% of the sediment samples were correctly predicted to be toxic. Therefore the target levels of both false positives (samples incorrectly classified as toxic) and false negatives (samples incorrectly classified as non toxic) was 25% using the TEC and PEC. The SQGs were considered to be reliable only if a minimum of 20 samples were included in the predictive ability evaluation (MacDonald et al., 2000). The results of the reliability analyses is summarized in the following table:

Reliability of Individual Consensus-Based Sediment Quality Guidelines (MacDonald et al., 2000)

Chemical	% of Samples Correctly Predicted to Be Non-Toxic based on TEC	TEC Reliable?	% of Samples Correctly Predicted to Be Toxic based on PEC	PEC Reliable?
Arsenic	74.1%	No	76.9%	Yes
Cadmium	80.4	Yes	93.7	Yes
Chromium	72.0	No	91.7	Yes
Copper	82.3	Yes	91.7	Yes
Lead	81.6	Yes	89.6	Yes
Mercury	34.3	No	100	Yes
Nickel	72.3	No	90.6	Yes
Zinc	81.6	Yes	90.0	Yes

Because field collected sediments contain a mixture of chemicals, a second predictive analyses was completed for use of the individual SQGs together in classifying a sediment as toxic or non-toxic. The incidence of effects was noted above and below various mean PEC quotients (ratios). The mean PEC ratio equals the average of the ratios of the concentration of the chemical to the corresponding PEC using on the PEC values that were found to be reliable. 92% of sediment samples with a mean PEC quotient > 1.0 were toxic to one or more species of aquatic organisms. The relationship between PEC quotient and incidence of toxicity is depicted in Figure 6-1. The mean PEC quotient was found to be highly correlated with incidence of toxicity ($r^2 = 0.98$) (MacDonald et al., 2000).

For the SERA, consensus-based SQGs from MacDonald et al. (2000) are used as a range of toxicity benchmarks for sediment. The TEC is used as the low benchmark and the PEC as the high benchmark. Consensus values are not available for aluminum, antimony, barium, beryllium, cobalt, cyanide, manganese, selenium, silver, thallium or vanadium. For aluminum and manganese the lowest and highest SEC values from Ingersoll et al. (1996) are used as the range of toxicity benchmarks for sediments. For silver, sediment toxicity benchmarks are the range of values reported by NOAA (ERL and ERM) (Long et al., 1995) and the state of Florida (MacDonald Environmental Sciences Ltd., 1994). For antimony the benchmarks are the range of values reported by Long and Morgan (1991). Sediment toxicity benchmarks could not be identified for barium, beryllium, cobalt, cyanide, selenium, thallium and vanadium.

For the SERA, the identified low and high sediment toxicity benchmarks are listed in Table 6-2. These values are compared to the EPC values for sediments for each sampling location (Section 5.1.2) to evaluate risks for benthic invertebrates for direct contact with COPCs in sediment in Section 7.1.2.

6.2 Toxicity Benchmarks for Amphibians

Screening benchmarks for the protection of amphibians from aqueous direct contact exposures are identified for several endpoints from the EPA AQUIRE database. With the exception of cyanide, the data available are LC50 values which represent a test concentration lethal to 50% of the test population. To estimate a toxicity benchmark value for no adverse effects, the lowest LC50 from the database is selected and the concentration is divided by ten. The only available endpoint for cyanide is avoidance behavior. Selected benchmarks are presented in Table 6-3. It should be noted that these benchmarks serve as screening values that do not account for site-specific factors which may either increase or reduce toxicity.

The toxicity screening benchmark for each COPC is compared to the EPC value for surface water and seep water to calculate HQ values in Sections 7.2.1 and 7.2.2, respectively.

6.3 Plant Toxicity Benchmarks

6.3.1 Screening Benchmarks for Soil

Plants are exposed to metals in soil principally through their roots. Exposure may also occur due to deposition of dust on foliar (leaf) surfaces, but this pathway is believed to be small compared to root exposure. Copper and zinc are considered to be essential or beneficial for plant growth (Kabata-Pendias and Pendias, 1992). However, excessive levels of these and other metals in soil may exert a variety of adverse effects on plants including reduced photosynthetic efficiency, reduced seed germination, and reduced root-mass formation. These phytotoxic responses may occur at the scale of the individual plant or may effect the entire plant community, resulting in areas of stressed and unhealthy vegetation. Stressed communities are often subject to invasion by weedy metals-tolerant species which in turn can result in the disruption and displacement of an entire plant community that would otherwise be found in an affected area. In some locations, lethality to plants can result, and areas with little or no vegetative cover may occur.

A relatively large body of literature exists regarding metal phytotoxicity. These studies show that the toxicity of metals in soils varies widely between different plant species, and also depends on a large number of soil parameters including soil type, organic content, water content, soil condition, soil chemistry, and soil pH (Adriano, 1986; Kabata-Pendias and Pendias, 1992; CH2MHill, 1987a; CH2MHill, 1987b; Efroymson et al., 1997a). This variability is evident by inspection of Table 6-4, which summarizes phytotoxicity benchmarks for metals that are recommended and used by different authors and groups.

These values vary over an order of magnitude or more for each metal. Screening benchmarks for cyanide and selenium could not be identified.

The low and high toxicity values identified in Table 6-4 are compared to EPCs in soil for each sampling location to evaluate risks for terrestrial plants in Section 7.3.1.

6.3.2 Screening Benchmarks for Water

Screening benchmarks for the protection of plants from aqueous exposures are available from the Oak Ridge National Laboratory (ORNL) (Efroymson et al., 1997a). The screening benchmarks developed by ORNL are assumed to be representative of exposures of plants to contaminants measured in soil solutions (e.g., from lysimeter samples or possibly from aqueous extracts of soil) or in very shallow groundwater (e.g., plants in the vicinity of seeps and springs).

Solution benchmarks include data from toxicity tests conducted using whole plants rooted in aqueous solutions. Tests are commonly conducted in this manner because plants are assumed to be exposed to contaminants in the solution phase of soil, and the presence of soil in test systems reduces the experimenter's degree of control over exposure (Efroymson et al., 1997a). It should be noted that these benchmarks are used for screening and do not account for site-specific soil and plant characteristics.

The phytotoxicity benchmarks are derived by rank-ordering the LOEC values and then selecting a benchmark that approximated the 10th percentile. If there were 10 or fewer values for a chemical, the lowest LOEC is used. If there are more than 10 values, the 10th percentile LOEC value is used. If the 10th percentile fell between LOEC values, a value is chosen by interpolation. Since these benchmarks are intended to be thresholds for significant effects on growth and production, test endpoints that indicate a high frequency of lethality are not appropriate. Therefore, when a benchmark is based on an LC50 or on some other endpoint that includes a 50% or greater reduction in survivorship, the value is divided by a factor of 5, an approximation of the ratio of the LC50 to the EC20. In all cases, benchmark values are rounded to one significant figure. The selected toxicity benchmarks for plants for aqueous exposures are presented in Table 6-5. These benchmarks are compared to EPCs for seep water (Section 5. 2.2) in Section 7.3.2 to evaluate risks for terrestrial plants associated with exposure to COPCs in seep water (groundwater data).

6.4 Soil Fauna Toxicity Benchmarks

Soil organisms are defined as organisms that live during an essential part of their life cycle in the soil. This includes both soil invertebrates (e.g., worms, some insects and arthropods, etc), and soil microbes (bacteria, fungi, etc.). Soil organisms are important components of the terrestrial ecosystem as prey for other species, and because they contribute substantially to litter breakdown. Soil invertebrates fragment and partially solubilize organic matter, while soil microorganisms mineralize complex organic molecules to simple molecules that can be taken up by roots, or further mineralized to CO_2 and H_20 (Eijsackers, 1994). Earthworms are probably the most important soil invertebrate in promoting soil fertility (Edwards, 1992). Their feeding and burrowing activities break down organic matter and release nutrients and improve aeration, drainage and aggregation of soil.

Soil organisms are distinguished as inhabitants of either pore water, mineral soil or the litter layer. Some scientists distinguish between "in soil" and surface-active organisms, but this distinction can be arbitrary and is not considered for this assessment. Soil organisms can be exposed to contaminants in soils by direct contact with metals in pore water, and ingestion of metals in mineral soil or the litter layer. Site-specific soil and invertebrate characteristics can influence the bioavailability and resulting toxicity of metals from the soils to soil organisms (Eijsackers, 1994).

Soil screening benchmarks for the protection of soil organisms and microbial processes are available from three different sources, including ORNL (Efroymson et al., 1997b), the National Institute of Public Health and the Environment (Bilthoven, the Netherlands) (RIVM, 1997), and the Canadian Council of Ministries of the Environment (CCME, 1997).

The screening benchmarks developed by ORNL for application at hazardous waste sites (Efroymson et al., 1997b) are derived using a method similar to that used by NOAA to establish the ERLs and ERMs for sediment (Long and Morgan, 1990). The data available on toxicity of a contaminant to soil organisms were reviewed and the lowest observed effect concentration (LOEC) was determined. The LOEC is defined as the lowest applied concentration of the chemical causing a greater than 20% reduction in the measured response. In some cases, the LOEC was the lowest concentration tested or the only concentration reported (EC50 or ED50 data). The LOECs were rank ordered and a value selected that approximated the 10th percentile. When a benchmark was based on a lethality endpoint, the benchmark value was divided by 5 to approximate an effects concentration for growth and reproduction. The factor was selected based on the author's judgement. The benchmark values were then rounded to one significant figure (Efroymson et al., 1997b). Efroymson et al. (1997b) developed screening benchmarks for earthworms and microorganisms and microbial soil processes.

The values developed by each of these groups are summarized in Table 6-6. As seen, in most cases the benchmarks developed by the different groups for each chemical vary by less than an order of magnitude. An exception is mercury, for which the range of soil invertebrate TRVs is substantially wider (300-fold). Screening benchmarks for antimony and cyanide could not be identified.

For the purposes of the SERA, the low and high toxicity benchmarks are compared to soil EPCs for each sampling location (Section 5.2.1) to calculate a range of HQ values in Section 7.4.

6.5 Wildlife Toxicity Reference Values (TRVs)

Two toxicity reference values (TRVs) are identified for each COPC for each representative wildlife species. The first TRV is an estimate of the dose (mg of contaminant per kg of body weight per day) that is not associated with any adverse effects to the species. This is referred to as the no observed adverse effect level (NOAEL) TRV. The second TRV is an estimation of the dose that first causes an observable adverse effect, and is referred to as the lowest observed adverse effect level (LOAEL) TRV. This range of TRVs is one way to bracket the true threshold for adverse effects.

The NOAEL and LOAEL TRVs are based on a critical review of published toxicity data. Two secondary sources (Sample et al., 1996 and Engineering Field Activity West, 1998) were used to identify key toxicological studies for each of the COPCs. The studies were reviewed to determine the relevance and reliability of the study results for derivation of a TRV. The critical studies used to derive the TRVs are presented in detail for each contaminant and each receptor in Appendix D.

Separate TRVs (both NOAEL-based and LOAEL-based) were developed for exposure via water and the diet. This distinction is based on the observation that the absorption (and hence the toxicity) of metals in the diet is usually lower than for metals dissolved in water. Both the water TRVs and the dietary TRVs were based on published toxicity data, wherever possible. If toxicity data were available for only one of these media (water or diet, but not both), a relative absorption factor of 50% was assumed to extrapolate to the other medium:

$$TRV(water) = TRV(diet) \times 0.50$$
$$TRV(diet) = TRV(water) / 0.50$$

This adjustment factor of 50% is based on professional judgement, but is supported by evidence that metals in water typically exist in a readily bioavailable form, and that dietary materials (proteins, carbohydrates, other minerals) tend to bind metals and/or compete for uptake sites, hence reducing their bioavailability. This concept has been used previously by USEPA in the derivation of food- and water-based Reference Doses (RfDs) for cadmium (IRIS, 1998).

In theory, separate TRVs are needed for sediment and soil ingestion, since absorption of contaminants from sediment may not be the same as from either food or water. However, there are no toxicity data for any of the COPCs to any of the representative wildlife species where the exposure occurs in the form of soil. Therefore, TRVs for food were used as surrogates for sediment and soil TRVs. It is considered likely that this approach may tend to overestimate exposure and risk from ingestion of sediment and soil, but this is not known for certain.

When reliable toxicity data could not be located for a representative species, it was necessary to extrapolate toxicity data from studies using another species. In some cases, available toxicity data were too limited to allow precise definition of NOAEL and LOAEL values for relevant endpoints. To account for these data gaps, each TRV was derived from the study dose level identified as the NOAEL or LOAEL by dividing by an Uncertainty Factor (UF) as follows:

$$TRV = Study\ Dose / UF$$

The value of UF was calculated as the product of a series of sub-factors. These sub-factors of uncertainty are presented in Table 6-7 and include inter-taxon extrapolation, exposure duration, toxicological endpoint, and other modifying factors such as threatened and endangered status, contaminant sensitivity, developmental differences, etc. In general, USEPA Region VIII recommends that HQ values be calculated only in cases where the total UF used to derive a TRV is less than 100. As seen in Appendix D, UFs used to derive TRVs are all below 100. The TRVs derived for each representative wildlife species are summarized in Table 6-8. The TRVs are compared to doses estimated for each wildlife species as described in Section 5.2 to estimate risks in Section 7.5.

7.0 SCREENING LEVEL RISK CHARACTERIZATION

Potential risks to ecological receptors from exposure to COPCs are characterized by use of a Hazard Quotient (HQ) approach. The HQ is defined as the ratio of the exposure point concentration (EPC) to the appropriate toxicity screening benchmark:

$$HQ = \frac{Exposure}{Benchmark}$$

If the effects of different chemicals on a receptor act on the same target tissue by the same mechanism, then the total Hazard Index (HI) to the receptor may be estimated as the sum of the chemical-specific HQ values across chemicals. At the RFT Site, it has been conservatively assumed that effects of all the metals on each of the receptors are additive.

$$Total\ HI_i \sum HQ_{i,r}$$

If the HQ or total HI is less than or equal to one, it is believed that unacceptable risks will not occur in the exposed population. If the HQ or total HI exceeds one, then unacceptable risks may occur and there is a need for further evaluation. All HQ and total HI values are presented to one significant digit.

7.1 Aquatic Receptors

7.1.1 Surface Water

Because the toxicity of COPCs in surface water to aquatic receptors is dependant on the length of exposure time, the HQ is calculated for both short-term (acute) and long-term (chronic) exposure conditions:

$$HQ_{acute} = \frac{C_{water}}{Benchmark_{acute}} \qquad HQ_{chronic} = \frac{C_{water}}{Benchmark_{chronic}}$$

The concentration of a contaminant in surface water may be expressed in terms of total recoverable metal or dissolved metal with the value of the denominator (benchmark) dependant on the type of concentration value selected.

$$HQ_{dissolved} = \frac{DissolvedC_{water}}{Benchmark_{dissolved}} \qquad HQ_{total} = \frac{TotalC_{water}}{Benchmark_{total}}$$

As discussed previously, the HQ based on the dissolved metal concentration is generally believed to be the best indicator of potential risks due to direct contact (e.g., gill respiration in fish), as this concentration represents the amount of the metal that is biologically available (USEPA, 1995). However, evaluation of risks to receptors based only on dissolved metal levels is not possible as dissolved benchmarks (criteria) are not available for all metals and dissolved measurements in surface water are not available for all COPCs for each surface water sampling station.

HQ values are calculated for COPCs in surface water and are presented in Table 7-1. The left-hand side of the table presents the total recoverable and dissolved COPC EPCs from each surface water sampling station. The corresponding acute and chronic AWQC values are also calculated. For those AWQCs that are dependant upon hardness, the average station hardness is used to derive the criteria. If the measured station hardness is outside of the specified hardness limits (Table 6-1), the applicable hardness limit are used to calculate the AWQC. If the station hardness is not available, a hardness of 200 mg/L is assumed. The right side of the table presents the resulting HQ_{acute} and $HQ_{chronic}$ values for dissolved and total recoverable COPCs. Where the HQ values exceed 1E+00, the values are in boldface type.

Figure 7-1 provides a plot of HQ values for all COPCs by surface water station. The lower point of the plotted range represents the HQ value calculated using the acute AWQC and the higher point represents the HQ value calculated using the chronic AWQC. Acute and chronic AWQC values for zinc are nearly equal depending on hardness, therefore a range of HQs is not presented for all stations.

Each of the following subsections discusses the surface water HQ results for both total recoverable and dissolved measurements for each COPC in which an exceedance of either acute or chronic toxicity screening levels (AWQC) occurs.

- ***Upstream Silver Creek.*** Zinc concentrations (both total and dissolved) at all sampling locations on Silver Creek upstream of the railroad bridge trestle are above levels associated with acute and chronic toxicity for aquatic receptors. At these stations, exceedances of the chronic toxicity criteria for total and dissolved cadmium are also observed with total cadmium levels also exceed the acute toxicity levels at station 492695. Total lead concentrations are above a chronic level of concern at all sampling locations with HQs ranging from 3 to 3,000. At sampling location N4, total concentrations of copper and mercury are above levels of acute and chronic toxicity. The dissolved concentrations of lead at station N4 are also above a chronic level of concern (HQ of 5) with total concentrations above an acute level of toxicity. Immediately upstream of the railroad bridge trestle (USC-3), dissolved aluminum concentrations are slightly above chronic toxicity levels (HQ of 2). At the furthest upstream location (USC-7), below Silver Maple Claims, total aluminum concentrations are also above chronic levels (HQ of 8).

- ***Downstream Silver Creek.*** Like the upstream section of Silver Creek, zinc concentrations (both total and dissolved) at all but three sampling locations on Silver Creek downstream of the railroad bridge trestle are above levels associated with acute and chronic toxicity for aquatic receptors. At three locations (RF-SW-06, USC-1 and RF-8) total aluminum concentrations are above chronic toxicity levels. Total and dissolved concentrations of cadmium are above chronic toxicity levels at all sampling locations except station 492679. At most sampling locations, total lead concentrations (and often dissolved concentrations) are above a level of chronic toxicity. Total mercury concentrations at station N6 are above acute and chronic toxicity levels (HQs range from 90 to 200).

- ***South Diversion Ditch.*** At most sampling locations in the south diversion ditch, both total and dissolved zinc concentrations are above levels associated with acute and chronic toxicity. Total zinc concentrations at RF-4 and RF-5-4 are 10 times greater than chronic toxicity levels. Dissolved chromium concentrations are above levels associated with acute toxicity at stations USC-4 and RF-6. Total concentrations of chromium are 7 times greater than chronic toxicity levels and 4 times greater than acute toxicity levels at USC-4. Total aluminum concentrations are above levels associated with chronic toxicity at most sampling locations with dissolved aluminum concentrations above a level of chronic toxicity at station RF-2. At RF-6-2, total arsenic concentrations exceed acute and chronic toxicity levels. Total lead concentrations slightly exceed levels of chronic toxicity (HQs ranging from 2 to 9) at several stations.

- ***Ponded Water on the Impoundment.*** The HQs for each COPC are below levels of acute and chronic toxicity. However, the total HI is above one for both total and dissolved metals based on chronic toxicity criteria and above one for dissolved metals based on acute toxicity criteria.

- ***Unnamed Drainage flowing into the South Diversion Ditch.*** At sampling location RF-3-2, all total and dissolved COPC concentrations, with the exception of total recoverable aluminum, are below levels of acute and chronic toxicity. Total aluminum concentrations are above levels of acute and chronic toxicity levels (HQs of 2 and 20, respectively).

The range of HQ values for aquatic receptors from surface water are summarized below.

Location	Al	As	Cd	Cr	Cu	CN	Pb	Hg	Se	Ag	Zn
Silver Creek - upstream	<1 to 8	All <1	<1 to 30	All <1	<1 to 20	All <1	<1 to 300	<1 to 200	<1to 2	All <1	3 to 400
Silver Creek - downstream	<1 to 4	All <1	<1 to 20	All <1	<1to 2	All <1	<1 to 60	<1 to 200	<1to 2	All <1	<1 to 8
South Diversion Ditch	<1 to 7	<1 to 5	<1 to 4	<1 to 7	All <1	All <1	<1 to 9	All <1	All <1	All <1	<1 to 10
Ponded Water	NA	All <1	<1to 2	All <1	All <1	NA	All <1	All <1	All <1	All <1	All <1
Unnamed Drainage	<1 to 20	All <1	All <1	All <1	All <1	NA	All <1	All <1	All <1	All <1	All <1

The concentrations of most COPCs are above levels of chronic and/or acute toxicity in Silver Creek upstream of the RFT Site. The headwaters of Silver Creek originate in the mountains south of Park City, Utah and include Deer Valley, Empire Canyon, Ontario Canyon, and Thaynes Canyon (Figure 3-6). Historically, these headwaters were the site of several mining operations such as the Little Bell and Daly

Mines. According to the Utah Division of Water Quality, water quality in the upstream portions of Silver Creek is impaired and concentrations exceed the state water quality standards for zinc (RMC, 2000b). During the watershed evaluation completed by EPA (USEPA, 2001a), surface water samples were collected at several locations in each canyon and along Silver Creek (see Figure 3-7). Measured surface water concentrations of cadmium, lead and zinc are presented graphically in Figure 7-2.

As seen in Figure 7-2, the highest concentrations of cadmium, lead and zinc are measured in Empire Canyon. Concentrations in Silver Creek tend to decrease with increasing distance downstream with increases observed at locations near Silver Maple Claims that receives flow from the Pace-Homer Ditch. According to the findings of the watershed evaluation (USEPA, 2001a), the Silver Maple Claims (Pace-Homer Ditch) was the largest contributor of zinc for the lower reaches of Silver Creek. Zinc loads from the RFT Site south diversion ditch are reported to contribute only 0.03 lbs/day to Silver Creek (USEPA, 2001a).

The following subsections provide further evaluation of the risks for cadmium, lead and zinc in surface water for fish and aquatic invertebrates, respectively.

7.1.1.1 Screening Evaluation for Fish

The "typical" concentrations of cadmium, lead and zinc in RFT Site surface waters are compared to species specific toxicity reference values (species mean TRVs). Figures 7-3a to 7-3c compare data on the available mean and maximum concentrations of dissolved cadmium, lead and zinc observed in Silver Creek and RFT Site surface waters to the range of species-mean toxicity values for the fish species that either occur in or are similar to species that occur in cold water streams (Table 7-2). The data for the south diversion ditch and the unnamed drainage is provided for comparison purposes. It is understood that this habitat is semi-permanent and is not expected to support a cold water fishery.

All of the toxicity values shown in Table 7-2 are derived from the corresponding AWQC Documents prepared by EPA (1985b-e, 1987, 1996, 2001b). Because the toxicity of cadmium, lead and zinc depend on water hardness, all of the data (both the toxicity values and the concentration values) are normalized to a default hardness of 100 mg/L using the following equation:

$$C(100) = C(H) \times TRV(100) / TRV(H)$$

where:

C(100) = normalized concentration
C(H) = original concentration (hardness = H)
TRV(100) = Acute AWQC (dissolved) at a hardness of 100 mg/L
TRV(H) = Acute AWQC (dissolved) at hardness = H

Site-specific data on water hardness are not available for all stations. If the station hardness is not available, a hardness of 200 mg/L is assumed.

For dissolved cadmium (Figure 7-3a), average concentrations for several locations in Silver Creek and maximum cadmium concentrations in the south diversion ditch enter a range of acute toxicity for brook trout and rainbow trout. As seen in Figure 7-3b, dissolved lead concentrations do not enter a range of acute or chronic toxicity for either brook trout or rainbow trout at any location, even when concentration values reach the maximum detected concentrations. For zinc (Figure 7-3c), average concentration values at station RF-7 in upstream Silver Creek exceed acute and chronic toxicity values for all fish species. All other zinc concentrations are below available species toxicity values.

7.1.1.2 Screening Evaluation for Aquatic Invertebrates

Many benthic macroinvertebrates live some or most of their life cycle on or near the surface of the sediment substrate, and hence the main source of water exposure is from the overlying surface water column (Warren et al., 1998). Data on the concentration of metals in surface water are presented earlier (see Section 3). In accord with EPA recommendations (Prothro, 1993), attention is focused on risks from contact with dissolved metals, since dissolved metal measurements are thought to be more predictive of risk compared to measurements of total recoverable metals.

Table 7-3 summarizes available water column toxicity data from the AWQC national database (USEPA, 1985b-e, 1987, 1996, 2001b) for benthic species that are expected to occur or are reasonable surrogates for other species that are expected to occur in the RFT Site waters. Daphnia are retained because they are usually among the most sensitive of aquatic invertebrates to the effects of metals, and therefore can serve as a surrogate for other sensitive aquatic macroinvertebrates which may reside in RFT Site surface waters, but standard toxicity values are not available.

Figures 7-4a to 7-4c compare data on the distribution of concentrations of dissolved metals observed in RFT Site surface waters to the range of genus-mean toxicity values for aquatic macroinvertebrates selected to represent the aquatic macroinvertebrate community. Because cadmium, lead and zinc toxicity depends on water hardness, all of the data (both the toxicity values and the concentration values) have been normalized to a hardness of 100 mg/L. The hardness-normalization equation is presented previously in Section 7.1.1.1. Site-specific data on water hardness are not available for all stations. If the station hardness is not available, a hardness of 200 mg/L is assumed.

For dissolved cadmium (Figure 7-4a), concentrations approach or exceed chronic toxicity values for cladocerans (Daphnia) at several locations in Silver Creek and the south diversion ditch. As seen in Figure 7-4b, dissolved lead concentrations do not enter a range of acute or chronic toxicity for any benthic macroinvertebrate genus or species evaluated at any location, even when concentration values reach the maximum detected concentrations. However for zinc (Figure 7-4c), average concentrations in Silver Creek and the south diversion ditch are frequently above levels of chronic toxicity for cladocerans (Daphnia). In addition, maximum concentration values in the south diversion ditch (RF-4 and RF-5-4) approach or exceed reported acute toxicity levels for Daphnia. These comparisons suggest that these and other aquatic invertebrate organisms may be exposed to cadmium and zinc concentrations that could impact or limit their populations.

7.1.2 Sediments

Risks for benthic invertebrates from exposures to COPCs in sediment are evaluated using two methods. The first is a HQ approach and the second is calculation of site-specific probable effect ratios that predict if the mixture of metals in site sediments will be toxic to benthic organisms.

7.1.2.1 Hazard Quotients

The risks to benthic invertebrates from exposures to COPCs in sediment are evaluated using an HQ approach as follows:

$$HQ = \frac{C_{sed}}{Benchmark_{sed}}$$

where:

C_{sed}	=	Concentration of COPC in sediment (mg/kg dry weight)
$Benchmark_{sed}$	=	Sediment screening benchmark (mg/kg dry weight)

Table 7-4 presents the maximum concentration of each COPC in sediment, stratified by location, with the corresponding range of sediment screening benchmarks (low and high toxicity benchmarks). HQs are calculated using both the low and high sediment toxicity benchmarks. The resulting range of HQ values are shown on the right-hand side of Table 7-4. In instances where the HQ exceeds 1, the HQ is shown in boldface type.

Figure 7-5 presents a plot of HQ values for aluminum, arsenic, cadmium, copper, lead, manganese, mercury, nickel, silver, and zinc stratified by sediment station. The lower point on the range represents the HQ value calculated using the high sediment toxicity benchmark (Table 6-2) and the higher point represents the HQ value calculated using the low sediment toxicity benchmark.

Based on the HQ values, potential risks for benthic invertebrates are predicted for exposures to aluminum, antimony, arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel, silver and zinc in sediments. The HQ values for cadmium, lead and zinc tend to follow similar trends across locations. A discussion of the HQ values for benthic invertebrates are provided by COPC in the following subsections:

- ***Upstream Silver Creek***. Antimony, arsenic, cadmium, copper, lead, mercury, silver and zinc sediment concentrations at all sampling locations along Silver Creek upstream of the railroad trestle are above levels associated with sediment toxicity to benthic invertebrates. Antimony, arsenic, cadmium, copper, lead, silver and zinc concentrations exceed both the low and high sediment toxicity benchmarks at all three upstream sampling locations. Mercury sediment concentrations exceed the low toxicity benchmark at all three upstream sampling locations but only station USC-6 exceeds the high toxicity benchmark (HQ of 2). Aluminum and chromium sediment concentrations are below a level of concern for benthic invertebrates (HQs less than or equal to 1) at all three upstream Silver Creek locations. The highest HQs are for COPCs observed at the sampling station below Silver Maple Claims (USC-6). At this station, the risks are predicted to range from 9 (mercury) to 1,000 (lead) based on the low toxicity benchmark values (TECs), and from 2 (mercury) to 300 (lead) based on the high toxicity benchmark values (PECs).

- ***Downstream Silver Creek.*** The HQ values for benthic invertebrates from direct contact with sediment at Silver Creek sampling locations downstream of the RFT Site are similar to those at upstream locations. At both Silver Creek downstream sampling locations antimony, arsenic, cadmium, copper, lead, silver and zinc sediment concentrations are higher than both the low and high toxicity benchmarks. At station USC-1, concentrations of mercury are higher than the low toxicity benchmark (HQ of 2). Aluminum and chromium concentrations are less than both benchmarks (HQs less than or equal to 1).

- ***South Diversion Ditch.*** Antimony, arsenic, cadmium, lead, silver and zinc sediment concentrations at almost all sampling locations in the south diversion ditch are above both the low and high toxicity benchmarks. Concentrations of copper exceed both the high and low toxicity benchmarks with the exception of locations RF-SD-SD2, -SD3, and -SD6. The concentrations of mercury in sediments exceed the low sediment toxicity benchmark at all sampling locations and the high benchmark at one location (RF-SD-SD1). Concentrations of aluminum and chromium are lower than both benchmarks with the exception aluminum at one station (RF-SD-SD6) where the HQ is 2. The highest HQ values are observed for cadmium, lead and zinc with values ranging from 20 (cadmium) to 100 (lead and zinc). The HQ ranges for other COPCs are generally lower.

- ***Wetland Area.*** Antimony, arsenic, cadmium, lead, silver and zinc exceed both the high and low toxicity benchmarks at all sampling locations. Concentrations of copper exceed the low toxicity benchmark at all locations and the high benchmark at two sampling locations (RF-SE-01 and RF-SE-03). The concentrations of mercury exceed the low toxicity benchmark at three locations and only the high benchmark at one location. Concentrations of manganese exceed the low toxicity benchmark at all locations and the high benchmark at all but one location (HQs range from 2 to 50). Concentrations of nickel exceed the low toxicity benchmark at RF-SE-01 and both the low and high toxicity benchmarks at RF-SE-04. Concentrations of aluminum and chromium are below a level of concern at all sampling locations.

The range of HQs and the relative frequency of exceedances for benthic invertebrate receptors from sediments are summarized in the following table.

Location	Al	Sb	As	Cd	Cr	Cu	Pb	Mn	Hg	Ni	Ag	Zn
Silver Creek - upstream	All <1	2 to 300	2 to 100	5 to 100	All <1	3 to 60	10 to 800	*NC*	<1 to 5	NC	7 to 100	8 to 300
Silver Creek - downstream	All <1	5 to 70	7 to 30	8 to 50	All <1	3 to 20	50 to 200	*NC*	<1 to 2	NC	10 to 50	20 to 80
South Diversion Ditch	<1 to 2	<1 to 50	3 to 20	4 to 70	All <1	<1 to 10	20 to 100	*NC*	<1 to 9	NC	4 to 30	6 to 100
South Diversion Ditch - Wetland	<1 to 2	2 to 50	5 to 30	8 to 90	All <1	<1 to 20	20 to 200	<1 to 70	<1 to 40	<1 to 4	2 to 50	10 to 100

NC= Not Calculated

As seen, sediments in upstream Silver Creek (above the RFT Site) tend to have the highest HQ values. According to the watershed evaluation (USEPA, 2001a), sediment concentrations are highest at and below Silver Maple Claims and are likely impacted by the tailings piles along the lower portions of Silver Creek. Historical releases from the RFT Site south diversion ditch may have also impacted sediments in Silver Creek (USEPA, 2001a).

7.1.2.2 Mean Probable Effect Concentration Ratio

As described earlier in Section 6, MacDonald et al. (2000) found that the mean PEC quotient was correlated with incidence of sediment toxicity ($r^2 = 0.98$). The resulting equation ($Y=101.48(1-0.36^x)$), where 'x' equals the mean PEC quotient and 'Y' equals the incidence of toxicity, can be used to estimate the probability of observing sediment toxicity at any mean PEC quotient. The mean PEC quotients calculated for each sediment sampling location are provided in Table 7-5 and the results are summarized in the following text table:

Calculation of the Mean PEC Quotient by Sampling Location and the Predicted Incidence of Observing Sediment Toxicity (MacDonald et al., 2000)			
Location	**Station**	**Mean PEC**	**Probability of Observing Sediment Toxicity**
Silver Creek Downstream	USC-1	19.8	100%
	USC-2	14.9	100%
Silver Creek Upstream	USC-5	21.3	100%
	USC-6	77.2	100%
	USC-7	6.5	100%
South Diversion Ditch	RF-SD-SD1	10.9	100%
	RF-SD-SD2	7.6	100%
	RF-SD-SD3	6.0	100%
	RF-SD-SD4	8.8	100%
	RF-SD-SD5	7.4	100%
	RF-SD-SD6	4.9	100%
Wetland Area	RF-SE-01	17.4	100%
	RF-SE-02	8.8	100%
	RF-SE-03	13.2	100%
	RF-SE-04	6.7	100%

The mean PEC ratio equals the average of the individual COPC specific ratios of the concentration of the COPC in sediment to the corresponding PEC value using only the PEC values that were found to be reliable. The mean PEC quotients for all sampling locations predict that samples are toxic to benthic invertebrates.

7.1.3 Seep Water

Potential risks for aquatic receptors from exposure to COPCs in seep water are characterized by use of the HQ approach. The HQ is defined as the ratio of the concentration of a COPC to the appropriate benchmark value:

$$HQ = \frac{C_{seep}}{Benchmark_{seep}}$$

where:

C_{seep} = Dissolved or Total Concentration of COPC in seep water (ug/L)
$Benchmark_{seep}$ = AWQC screening benchmark for Total or Dissolved Concentrations (ug/L)

HQ values for aquatic receptors are calculated for COPCs in seep water (as estimated from groundwater) and are presented in Table 7-6. The left-hand side of the table presents the maximum total recoverable and dissolved COPC concentrations from each groundwater monitoring well. The corresponding acute and chronic AWQC values are also presented. Where the HQ values exceed 1E+00, the values are in boldface type. Calculated HQs for total and dissolved COPCs are shown graphically in Figure 7-6. If the value of the HQ exceeds one, then potential risks may occur and there is a need for further evaluation.

A summary of the seep water HQ results for each COPC in which an AWQC exceedance occurred is provided below.

Location	Al	As	Cd	Cr	Cu	CN	Pb	Hg	Se	Ag	Zn
Seep Water @ Main Embankment	<1 to 900	<1 to 2	<1 to 90	<1 to 9	<1 to 90	<1 to 2,000	<1 to 30	<1 to 3	<1 to 3	All <1	<1 to 10
Background Groundwater	<1 to 200	All <1	<1 to 8	<1 to 2	<1 to 10	All <1	<1 to 100	All <1	All <1	All <1	All <1

The ranges of HQ values exceed one for all COPCs, with the exception of silver, at all monitoring wells located at the base of the main embankment. Total concentrations have consistently higher HQ values than those predicted for dissolved. Concentrations of cyanide along with lead and mercury are found to be the most common contributors to risks.

7.2 Amphibians

The diversity, density, and the reproductive success (i.e. embryonic mortality) of amphibians are shown to be sensitive indicators of environmental stress. If amphibians are found to encounter reproductive failure compared to reference wetlands, amphibian reproductive success and diversity, and subsequently structure and function as a whole would be determined to be at risk.

The basic equation used for calculation of an HQ value for the direct contact exposure of amphibians to COPCs in aqueous media is:

$$HQ_{amphib} = \frac{Conc_{water}}{TB_{amphibian}}$$

where:

$Conc_{water}$ = Total Recoverable concentration of COPC in water (ug/L)
$TB_{amphibian}$ = Toxicity benchmark (ug/L) for exposure of amphibians to COPCs in aqueous media

HQ values are calculated using the amphibian toxicity benchmark TRV for each COPC. If all HQ values are found to be below one, it would then be concluded that hazard to amphibians from exposure to COPCs in water is low. Conversely, if a majority of HQ values based on the benchmark TRV are found to be substantially higher than one, it should be concluded that toxicity to amphibians from exposure to COPCs in water is likely.

7.2.1 Surface Water

HQ values for the exposure of amphibians via surface water are calculated for each COPC and are presented in Table 7-7. The left-hand side of the table presents the maximum total recoverable COPC concentrations from each surface water sampling station. If total concentrations are not available, the dissolved concentrations are used to calculate HQs. The corresponding amphibian toxicity benchmark screening values are also presented. Where the HQ values exceed 1E+00, the values are in boldface type. A summary of the total HI at each sampling station and the contribution of each COPC HQ to the total HI is presented in Figure 7-7.

A summary of the surface water HQ results for each COPC in which an exceedance of the amphibian toxicity screening benchmark occurs is provided in the following paragraphs.

- ***Upstream Silver Creek.*** Zinc and copper concentrations at all sampling locations and lead concentrations at all but one sampling location are above levels associated with toxicity to amphibians. Copper HQs typically are less than 5 times greater than the toxicity value. Slight exceedances of the cadmium and arsenic toxicity benchmarks are observed at several sampling locations with maximum HQs of 3 and 5, respectively. Cyanide concentrations at sampling location RF-7-2 and N4 are also above the toxicity value, with HQs of 8 and 200, respectively. Mercury concentrations at these stations and at station RF-7 exceed of the toxicity value as well. Selenium and silver concentrations are below respective toxicity values at all stations.

- ***Downstream Silver Creek.*** The HQ values and frequency of exceedances of amphibian toxicity values at locations in Silver Creek downstream of the south diversion ditch confluence are similar to those observed upstream. Like upstream Silver Creek, zinc and lead concentrations at all but one sampling location are above respective toxicity values. Arsenic and copper HQs are greater than 1 at all but one location, with maximum HQs of 8 and 3, respectively. At station RF-8, cadmium concentrations are slightly above the toxicity value (HQ of 2). Cyanide is measured at only three sampling locations, but concentrations are above the toxicity value at all locations with a maximum HQ of 20. Calculated HQs for mercury at most locations are below 1, however, HQs are greater than 1 at N6, RF-8, and RF-8-2. Similar to upstream Silver Creek, selenium and silver concentrations are below toxicity values at all stations.

- ***South Diversion Ditch.*** Total zinc concentrations at every sampling location in the south diversion ditch are above toxicity levels. Zinc concentrations at RF-4 and RF-5-4 exceed the toxicity value by 3,000 times. At most sampling locations, total arsenic concentrations (HQs ranging from <1 to 200), total copper concentrations (HQs ranging from <1 to 5) and total mercury concentrations (HQs ranging from <1 to 3) exceed respective toxicity values. Concentrations of lead at several locations in the south diversion ditch are also above the toxicity value with a maximum HQ of 10. Total cyanide is available for only one location. At this location concentrations are 8 times greater than the toxicity value. Cadmium, selenium and silver concentrations are below a level of concern at all sampling locations.

- ***Ponded Water on the Impoundment.*** At sampling location RF-9, measured concentrations of arsenic and mercury are slightly above respective toxicity values (HQs of 3). Zinc concentrations are also above the toxicity value (HQ of 10). All other COPC concentrations are below levels of concern for amphibians.

- ***Unnamed Drainage flowing into the South Diversion Ditch.*** At sampling location RF-3-2, concentrations of arsenic, copper, and mercury are slightly above respective toxicity values (HQs ranging from 2 to 5). Total zinc concentrations are above the toxicity value with an HQ of 100. Concentrations of all other COPCs are below a level of concern for amphibians.

The range of HQs for amphibians from surface water are summarized below.

Location	As	Cd	Cu	CN	Pb	Hg	Se	Ag	Zn
Silver Creek - upstream	<1 to 5	<1 to 3	2 to 100	<1 to 30	<1 to 400	<1 to 1000	All <1	All <1	800 to 100,000
Silver Creek - downstream	<1 to 8	<1 to 2	<1 to 10	<1 to 20	<1 to 90	<1 to 1000	All <1	All <1	200 to 2,000
Site Ponded Water	3	<1	<1	NC	<1	3	<1	<1	10
South Diversion Ditch	<1 to 200	All <1	<1 to 5	<1 to 8	<1 to 10	<1 to 3	All <1	All <1	90 to 3,000
Unnamed Drainage	3	<1	56	NC	<1	2	<1	<1	100

The HQ values indicate that potential risks for amphibians associated with exposures to arsenic, copper, lead, mercury and zinc in the surface waters of Silver Creek both upstream and downstream of the RFT Site, the South Diversion Ditch, site ponded water and the Unnamed Drainage on the RFT Site. Adverse effects associated with lead, mercury, and zinc (as shown by the size of the ratio and frequency of exceedances) are predicted to be the most severe and frequent.

Figures 7-8a to 7-8e compare data on the distribution (mean and maximum) of typical concentrations of total recoverable concentrations of arsenic, copper, lead, mercury and zinc observed in Silver Creek and in RFT Site surface waters to the range of species toxicity values for amphibians. The toxicity values shown are derived from AWQC Documents (USEPA 1985b-e, 1987, 1996, 2001b) and are presented in Table 7-8. As seen in Figure 7-8a, arsenic concentrations in Silver Creek and in RFT Site waters are all below available toxicity values for amphibians. Copper concentrations (Figure 7-8b), with the exception of station N4, are also all below toxicity levels for available amphibian species. In Figure 7-8c, maximum lead concentrations at stations RF-7-2 in upstream Silver Creek, USC-1 and USC-2 in downstream Silver Creek, and RF-6 and N5 in the south diversion ditch are all above the EC50 for the marrow mouthed toad. Stations N4 and N6 are greater than toxicity values for the leopard frog and marbled salamander, but these concentrations appear to be anomalous in comparison with other measured lead concentrations. Maximum total mercury concentrations (Figure 7-8d) at station RF-7-2 in upstream Silver Creek, station RF-8 in downstream Silver Creek, and RF-4 in the south diversion ditch are above a level of concern for the African clawed frog. Mercury concentrations at stations N4 and N6 are several orders of magnitude above typical concentrations in other surface water, the reason for this discrepancy is not known at this time. Zinc concentrations (Figure 7-8e) at most locations are above the EC50 for the narrow-mouthed toad, but are below a level of concern for the African clawed toad and the marbled salamander with the exception of station RF-7.

7.2.2 Seep Water

HQ values for amphibians are calculated for COPCs in seep water (as estimated from groundwater) and are presented in Table 7-9. The left-hand side of the table presents the maximum total recoverable COPC concentrations from each groundwater monitoring well. If total concentrations are not available, the dissolved concentrations are used to calculate HQs. The corresponding amphibian toxicity benchmark screening values are also presented. Where the HQ values exceed 1E+00, the values are in boldface type.

A summary of the seep water HQ results for each COPC in which an toxicity benchmark exceedance occurred is provided below. A summary of the total HI at each monitoring well and the contribution of each COPC HQ to the total HI is presented in Figure 7-9.

Location	As	Cd	Cu	CN	Pb	Hg	Se	Zn
Seep Water @ Main Embankment	20to90	4 to 10	3 to 400	30 to 50,000	20 to 30	3 to 22	2	70 to 3,000
Background Groundwater	<1	<1	8	20	200	2	<1	100

Inspection of these HQ values shows exceedances of the toxicity values for amphibians to a greater extent for seep waters at the base of the main embankment compared to background waters for almost all COPCs. The highest HQ values are observed for cyanide and zinc, however, seep water concentrations of arsenic, cadmium, copper, lead and mercury also exceed respective amphibian toxicity values indicating potential risk associated with these COPCs.

7.3 Plants

7.3.1 Soil

The basic equation used for calculation of an HQ value for exposure of plants to COPCs in soils is:

$$HQ_{plant} = \frac{Conc_{soil}}{TB_{plant}}$$

where:

$Conc_{soil}$ = Concentration of metal in soil (mg/kg)
TB_{plant} = Phytotoxicity benchmark value (mg/kg) for COPC (Table 6-4)

As discussed previously, HQ values for plants are calculated based on total recoverable COPC concentrations in soil samples from each sampling location. HQ values are calculated based on the low and the high phytotoxicity value (from Table 6-4) for each COPC. These results are presented in Appendix F. If all HQ values based on the low phytotoxicity benchmark are below one, it is concluded that risks for plants associated with direct contact to COPCs in surface soils are not expected. Conversely, if the majority of HQ values based on the high benchmark are substantially higher than one, it is concluded that phytotoxicity is likely.

The HQ results (Appendix F) are summarized graphically in Figure 7-10 by soil type (background, on-impoundment, off-impoundment and tailings). For each COPC, HQs calculated using the low and high phytotoxicity benchmarks (Table 6-4) are presented in the upper and lower panels, respectively. The HQ ranges presented for each general soil type represent the minimum and maximum calculated HQs; the average HQ is also presented. The following table summarizes the HQ values for plants from exposure to COPCs in soil.

Location	Al	Sb	As	Ba	Cd	Cr	Cu	Pb	Hg	Se	Ag	Zn
Background Soils	NA	NA	all <1	all <1	all <1	20	all <1	<1 to 2	all <1	3	<1	2 to 3
Off-Impoundment Soils	NA	NA	<1 to 30	all <1	<1 to 7	20 to 30	all <1	<1 to 100	all <1	3	<1	2 to 30
On-Impoundment Cover Soils	400 to 500	<1 to 2	<1 to 10	all <1	<1 to 2	20 to 40	all <1	<1 to 60	all <1	3	<1	<1 to 20
Site Tailings	40 to 300	9 to 50	<1 to 30	NA	<1 to 10	9 to 30	<1 to 7	2 to 200	all <1	3 to 10	6 to 30	60 to 200

NA = Not Analyzed

- ***Background Soils.*** The concentrations of most COPCs in background soils are below the low toxicity benchmark for plants. These HQs indicate that phytotoxicity is not likely to occur as a result of direct contact with these COPCs in soil. HQ values for chromium, lead, selenium and zinc are all slightly above one, but are lower than HQ values observed for either on-impoundment or off-impoundment soils.

- ***Off-Impoundment Soils.*** The average concentrations of arsenic, chromium, lead, selenium and zinc in off-impoundment soils are above the phytotoxicity benchmarks (HQs ranging from 2 to 100). These HQs indicate that phytotoxicity is likely to occur as a result of direct contact with these COPCs in soil. HQs for barium, copper, mercury and silver are all below one. Cadmium HQs based on maximum concentrations are slightly above one for off-impoundment soils using the low phytotoxicity benchmark.

- ***On-Impoundment Soils.*** Aluminum and chromium HQs for all on-impoundment soils are above a both the low and high phytotoxicity benchmarks (maximum HQ of 500 for aluminum). These HQs indicate that phytotoxicity is likely to occur as a result of direct contact with these COPCs in soil. HQ values for barium, copper, mercury and silver are all below one. HQ values based on the low phytotoxicity benchmark for antimony, arsenic, cadmium are slightly above one, while maximum HQ values for lead and zinc range from 20 to 60.

- ***Tailings.*** HQ values for all COPCs except mercury are above the low phytotoxicity benchmarks. The highest HQs are for lead and zinc (HQs of 200 compared to the low phytotoxicity benchmarks). These HQ values indicate that phytotoxicity is probable if direct contact for plants were to occur with tailings material. The extent of existing soil cover (both depth and extent) as well as the root zone depth of existing vegetation cover is key to understanding if these exposures are possible.

Figure 7-11 presents the contribution of each COPC HQ to the total HI for each general location (background, off-impoundment and off-impoundment). The COPCs which contribute most to the HI are aluminum, lead and zinc. The HQ values depicted in the figure are based on the average soil concentrations of each COPC across available depths at a sampling location.

7.3.2 Seep Water

The basic equation used for calculation of an HQ value for exposure of plants to COPCs in seep water is:

$$HQ_{plant} = \frac{Conc_{soil}}{TB_{plant}}$$

where:

$Conc_{soil}$	=	Concentration of metal in soil (ug/L)
TB_{plant}	=	Phytotoxicity Benchmark Value (ug/L) for COPC (Table 6-5)

HQ values for plants are calculated for COPCs in seep water (as estimated from groundwater) and are presented in Table 7-10. The left-hand side of the table presents the total recoverable and dissolved COPC EPCs from each groundwater monitoring well. The corresponding phytotoxicity screening benchmark for solution exposures for each COPC is also presented. Where the HQ values exceed one, the values are in boldface type. If the HQ exceeds one, then potential risks may occur and there is a need for further evaluation. The calculated HQs for plants from direct contact with seep water are summarized below.

Location	Aluminum	Arsenic	Chromium	Copper	Lead	Manganese	Zinc
Seep Water @ Main Embankment	20 to 300	80 to 300	<1 to 2	<1 to 30	4 to 7	<1 to 4	<1 to 7
Background Groundwater	50	4	all <1	all <1	30	all <1	all <1

Figure 7-12 presents the contribution of each COPC to the total HI at each groundwater monitoring well. The primary contributors to risk at the base of the main embankment are aluminum, arsenic, copper and lead (maximum HQs of 300). Concentrations of these COPCs in upgradient (background) wells are also above the phytoxicity benchmarks. Concentrations of beryllium, cadmium, cobalt, mercury and selenium at all locations are all below a level of concern (HQs < 1). For upgradient (background) groundwater, concentrations of chromium, copper, manganese and zinc are below respective phytotoxicity benchmarks.

These HQ values indicate that risks for terrestrial plants associated with direct contact with aluminum, arsenic, copper and lead in seep water are possible. These HQ calculations are screening level estimates based on estimates of seep water concentrations of each COPC from available groundwater monitoring well data. Conclusions may change in the baseline risk assessment as more information on the extent of contamination of seeps becomes available.

7.4 Soil Fauna

The basic equation used for calculation of an HQ value for exposure of soil fauna to COPCs in soils is:

$$HQ_{soil\ fauna} = \frac{Conc_{soil}}{TB_{soil\ fauna}}$$

where:

$Conc_{soil}$ = Concentration of COPC in soil (mg/kg)
$TB_{soil\ fauna}$ = Toxicity benchmark (mg/kg) for COPC for soil fauna

HQ values are calculated based on the low and high toxicity benchmark for each COPC (Table 6-6). These results are presented in Appendix G for each soil sampling location for each COPC. If all HQ values are below one based on the low toxicity benchmark, it is concluded that risks to soil fauna associated with direct contact to COPCs in surface soils are not expected. Conversely, if the majority of HQ values based on the high benchmark are higher than one, it is concluded that adverse effects to soil fauna toxicity are likely.

The HQ results are summarized graphically in Figure 7-13 by soil type (background, on-impoundment, off-impoundment and tailings). For each COPC, HQs calculated using the low and high toxicity benchmarks (Table 6-6) are presented in the upper and lower panels, respectively. The HQ ranges presented for each general soil type represent the minimum and maximum calculated HQs; the average HQ is also presented. The following table summarizes the HQ values for soil fauna from exposure to COPCs in soil.

Location	Al	As	Ba	Cd	Cr	Cu	Pb	Hg	Se	Ag	Zn
Background Soils	NA	all <1	all <1	all <1	<1 to 60	all <1	all <1	<1 to 2	all <1	all <1	all <1
Off-Impoundment Soils	NA	<1 to 10	all <1	<1 to 20	<1 to 80	<1 to 2	<1 to 40	<1 to 30	all <1	all <1	<1 to 10
On-Impoundment Soils	30 to 40	<1 to 6	all <1	<1 to 4	<1 to 90	<1 to 2	<1 to 20	<1 to 10	all <1	all <1	<1 to 10
Site Tailings	3 to 30	<1 to 20	NA	<1 to 40	<1 to 80	<1 to 20	2 to 80	<1 to 200	<1 to 6	all <1	5 to 90

NA = Not Analyzed

- ***Background Soils.*** The concentrations of most COPCs in background soils are below respective low toxicity benchmarks for soil fauna. These HQs indicate that adverse effects to soil fauna is not likely to occur as a result of direct contact with these COPCs in soil. The HQ values for chromium and mercury are slightly above one, but are lower than HQ values for the Off and On–Impoundment Soils.

- ***Off-Impoundment Soils.*** The average concentrations of arsenic, cadmium, chromium, lead, mercury and zinc in off-impoundment soils are above the low toxicity benchmarks (HQs ranging from 2 to 60). These HQ values indicate that adverse effects to soil fauna is likely to occur as a result of direct contact with these COPCs in soil. HQ values for barium, selenium and silver are all below one. Copper HQs based on maximum concentrations are slightly above one (HQ of 2).

- ***On-Impoundment Soils.*** Aluminum HQ values for on-impoundment soils are above a level of concern (maximum HQ of 40). These HQ values indicate that adverse effects to soil fauna is likely to occur as a result of direct contact with aluminum in soil. HQ values for barium, selenium and silver are all below one. Maximum HQs based on the low toxicity benchmark exceed one for arsenic, cadmium, chromium, copper, lead, mercury and zinc.

- ***Tailings.*** All measured concentrations of aluminum, copper, lead and zinc in tailings are above toxicity benchmarks for soil fauna. Average HQ values for arsenic, cadmium, chromium, mercury and selenium exceed respective low toxicity benchmarks. The highest HQs are observed for mercury (maximum HQ of 200 compared to the low benchmark).

These HQ values indicate that adverse effects to soil fauna is likely if these receptors are exposed to the tailings material under the current soils cover.

Figure 7-14 presents the contribution of each COPC HQ to the total HI for each general soil location (background, off-impoundment, and on-impoundment). The COPCs which contribute most to the HI are aluminum, chromium, lead, mercury and zinc, but other COPCs also contribute to risks. The HQ values in the figure are based on average soil concentrations of each COPC across available depths.

7.5 Wildlife Receptors

7.5.1 Surface Water

Potential risks for wildlife receptors from exposure to COPCs in surface water are characterized by use of the HQ approach. The HQ is defined as the ratio of the dose to the appropriate TRV (Table 6-8):

$$HQ_{sw} = \frac{Dose_{sw}}{TRV_{water}}$$

where:

$Dose_{sw}$ = Average Daily Dose of COPC via ingestion of surface water (mg/kg BW/day)
TRV_{water} = Toxicity reference value for ingestion of water (mg/kg BW/day)

The basic approach used for estimating exposure and risk for wildlife receptors is to estimate the dose and the HQ for each COPC separately, and then to add HQs across all COPCs to derive a hazard index (HI). If the HI is less than or equal to one, no unacceptable risks to the exposed wildlife receptor is assumed. If the value of the HI exceeds one, then potential risks may occur and there is a need for further evaluation.

HI values are presented using both NOAEL and LOAEL TRVs (described in Section 6.5). All HI values are represented to one significant digit. HI values are calculated for each receptor for each exposure area (upstream Silver Creek, downstream Silver Creek, south diversion ditch, ponded water and unnamed drainage) and are summarized in the following text table. The detailed HQ_{sw} values calculated for each COPC are provided in Appendix E for each wildlife receptor.

Receptor	Hazard Indices for Surface Water Ingestion				
	Silver Creek Upstream	Silver Creek Downstream	South Diversion Ditch	Ponded Water	Unnamed Drainages
Cliff Swallow	all < 1	all < 1	all < 1	all < 1	all < 1
Greater-Sage Grouse	**< 1 to 2**	all < 1	all < 1	all < 1	all < 1
Mallard Duck	all < 1	all < 1	all < 1	all < 1	all < 1
Belted Kingfisher	all < 1	all < 1	all < 1	all < 1	all < 1
American Robin	all < 1	all < 1	all < 1	all < 1	all < 1
American Kestrel	all < 1	all < 1	all < 1	all < 1	all < 1
Red Fox	all < 1	all < 1	all < 1	all < 1	all < 1
Masked Shrew	**< 1 to 4**	all < 1	all < 1	all < 1	all < 1
Mink	all < 1	all < 1	all < 1	all < 1	all < 1
Deer Mouse	all < 1	all < 1	all < 1	all < 1	all < 1

As seen, HI values for almost all wildlife receptors are less than one for each exposure area. The HQ values indicate that risks for wildlife related to ingestion of COPCs in surface water are unlikely. The exception is for the greater-sage grouse and the masked shrew at upstream locations on Silver Creek with HIs ranging from <1 to 2 and <1 to 4, respectively. A review of the detailed HQ values presented in Appendix E shows that the majority of the risk observed in the upstream Silver Creek areas is attributable to total concentrations of lead in the surface water.

7.5.2 Sediment

Potential risks for wildlife receptors from exposure to COPCs in sediment are characterized by use of the HQ approach. The HQ is defined as the ratio of the dose associated with ingestion of sediments to the appropriate dietary TRV (Table 6-8):

$$HQ_{sed} = \frac{Dose_{sed}}{TRV_{diet}}$$

where:

$Dose_{sed}$ = Average Daily Dose of COPC via incidental ingestion of sediment (mg/kg BW/day)
TRV_{diet} = Toxicity reference value for dietary exposure (mg/kg BW/day)

HI values are presented in the following text table as a range using both NOAEL and LOAEL TRVs (Table 6-8). HQs are calculated for each COPC for each exposure area (upstream Silver Creek, downstream Silver Creek, south diversion ditch and wetlands area). The detailed HQ_{sed} values calculated for each COPC are provided in Appendix E.

Receptor	Hazard Indices for Sediment Ingestion			
	Silver Creek Upstream	Silver Creek Downstream	South Diversion Ditch	Wetlands Area
Belted Kingfisher	40 to 80	10 to 20	3 to 10	8 to 20
Mallard Duck	40 to 80	10 to 20	3 to 10	8 to 20
Mink	50 to 100	10 to 30	5 to 20	10 to 30

HI values for each receptor exceed one for all exposure areas. Based on relative HI values, the greatest risks are predicted for receptors at upstream locations on Silver Creek. A review of the detailed HQ values presented in Appendix E reveals which COPCs are contributing to the majority of the predicted risk within each exposure area. Figure 7-15 presents the contribution of each COPC to the total HI for sediment ingestion for each wildlife species.

For the belted kingfisher and mallard exposed to COPCs by ingestion in upstream Silver Creek., aluminum, arsenic, cadmium, lead and zinc contribute most to the total HI (Figure 7-15). Most of the total HI is attributable to lead (HQs range from 30 to 70). Aluminum, antimony, arsenic and lead HQs are all greater than one for the mink. Almost all of the total HI for mink is attributable to antimony (HQs range from 20 to 60) and lead (HQs range from 30 to 60).

For downstream Silver Creek, the South Diversion Ditch and the Wetlands Area the HQ values for most COPCs, with the exception of aluminum and lead, are less than one for the belted kingfisher and the mallard. For the mink, aluminum, antimony and lead HQ values are greater than one. All other COPC HQs are less than one. For mink, HQ values for thallium in the wetland area greater than one. In general, the HI values are highest for the wetland area followed by downstream Silver Creek and the South Diversion Ditch.

7.5.3 Seeps

Potential risks for wildlife receptors from exposure to COPCs in seep water are characterized by use of the HQ approach. The HQ is defined as the ratio of the dose to the appropriate TRV (Table 6-8):

$$HQ_{seep} = \frac{Dose_{seep}}{TRV_{diet}}$$

where:

$Dose_{seep}$ = Average Daily Dose of COPC via ingestion of seep water (mg/kg BW/day)
TRV_{diet} = Toxicity reference value for water exposure (mg/kg BW/day)

For the purposes of the SERA, it is conservatively assumed that 100% of the drinking water for each representative species comes from seeps.

HI values are presented in the following text table as a range using both NOAEL and LOAEL TRVs (Table 6-8). HI values are calculated for each representative species for each exposure area (upgradient wells and wells below main embankment). The detailed HQ_{seep} values calculated for each COPC for each representative species are provided in Appendix E. A summary of the results is provided in the following text table.

Receptor	Hazard Indices for Seep Water Ingestion	
	Upgradient Monitoring Wells	Monitoring Wells below Main Embankment
Cliff Swallow	all < 1	all < 1
Greater-Sage Grouse	all < 1	all < 1
Mallard Duck	all < 1	all < 1
Belted Kingfisher	all < 1	all < 1
American Robin	all < 1	all < 1
American Kestrel	all < 1	all < 1
Red Fox	all < 1	all < 1
Masked Shrew	< 1 to 3	all < 1
Mink	all < 1	all < 1
Deer Mouse	all < 1	all < 1

HQs based on the NOAEL and the LOAEL TRV for almost all representative wildlife species are less than one for the ingestion of seep water. The exception is the masked shrew, for which lead HQ values for upgradient groundwater are greater than one (based on the NOAEL TRV) (Figure 7-16). The lead HQ based on the NOAEL TRV for the masked shrew is 3.

7.5.4 Soil

Potential risks for wildlife receptors from exposure to COPCs in soils are characterized by use of the HQ approach. The HQ is defined as the ratio of the dose to the appropriate TRV (Table 6-8):

$$HQ_{soil} = \frac{Dose_{soil}}{TRV_{diet}}$$

where:

$Dose_{soil}$ = Average Daily Dose of COPC via incidental ingestion of soil (mg/kg BW/day)
TRV_{diet} = Toxicity reference value for COPC for dietary exposure (mg/kg BW/day)

The HI values for each representative wildlife species for each exposure area are summarized in the following text table using both NOAEL and LOAEL TRVs (Table 6-8). The detailed HQ_{soil} values calculated for each COPC are provided in Appendix E for each representative wildlife species.

Receptor	Hazard Indices for Soil Ingestion			
	Background Soils	Off-Impoundment Soils	On-Impoundment Soils	Site Tailings
American Robin	2 to 5	10 to 30	20 to 60	70 to 200
American Kestrel	all < 1	< 1 to 2	<1 to 4	5 to 10
Greater-Sage Grouse	all < 1	all < 1	all < 1	<1 to 3
Red Fox	all < 1	< 1 to 2	2 to 10	8 to 20
Masked Shrew	20 to 70	20 to 60	400 to 2,000	3,000 to 8,000
Deer Mice	all < 1	3 to 8	8 to 30	30 to 90

Based on relative HI values, the risks predicted for the masked shrew are the highest observed for any of the representative wildlife species with HI values greater than of one for all exposure areas. The highest risks are predicted for ingestion of tailings with HI values as low as <1 to 3 for the greater sage grouse to a 8,000 for the masked shrew. Risks for exposure to On-impoundment soils is higher than Off-Impoundment soils. The lowest overall risks are predicted for representative wildlife species exposed to soils at areas identified as background.

A review of the detailed HQ values presented in Appendix E reveals which COPCs are contributing to the predicted risk for each exposure area. Figure 7-17 provides a summary of the contribution of COPCs to the HI for each representative wildlife species for each exposure area. These results are discussed in the following paragraphs.

- ***Background Soils.*** HQs and total HIs for the American kestrel, red fox, deer mouse, and greater-sage grouse are all less than one. For the American robin, chromium concentrations are slightly above the selected NOAEL TRV (HQ of 2). Calculated HQs for arsenic, barium, and lead are all greater than one for the masked shrew, with the highest HQ values observed for lead (HQ range from 20 to 50).

- ***Off-Impoundment Soils.*** Similar to background soils, HQs and total HIs for the American kestrel, the red fox, and the greater-sage grouse are all less than one. HQs for the American robin are greater than one for barium, cadmium, lead, and zinc (maximum HQ of 10). HQs for the masked shrew are greater than 1 for arsenic, barium, cadmium, lead, and zinc. Lead concentrations contributed the most to the total HI. For the deer mouse, only lead HQs (range of 2 to 6) are greater than one. In general, HI values for all representative wildlife species are higher for Off-Impoundment soils compared to background.

- ***On-Impoundment Soils.*** Total HIs for on-impoundment soils are greater than one for all representative wildlife species except the greater-sage grouse. Aluminum, chromium, and lead HQs contributed most to the total HI. In addition to these COPCs, antimony, arsenic, barium and zinc also contribute significantly to the total HI for the masked shrew. In general, HI values for all representative wildlife species are higher for On-Impoundment soils compared to off-impoundment soils.

- ***Tailings.*** The total HI values for all representative wildlife species are greater than one. HQ values for lead and antimony contributed the most to the total HI for most species. However, HQs for other COPCs such as aluminum, arsenic, cadmium, chromium, copper, mercury, selenium and zinc also contribute to risks for the American robin and masked shrew. In general, HI values for all representative wildlife species are higher for tailings compared to on-impoundment soils.

HI values greater than one for at least one species within all exposure areas indicate that risks for wildlife related to incidental ingestion of soils is likely. The COPCs which contribute most to excess risks are aluminum, antimony and lead; however, other COPCs are also of concern for the American robin and masked shrew.

7.5.5 Food Chain

Potential risks for wildlife receptors from exposure to COPCs in food chain items are characterized by use of the HQ approach. The HQ is defined as the ratio of the dose to the appropriate TRV (Table 6-8):

$$HQ_{diet} = \frac{Dose_{diet}}{TRV_{diet}}$$

where:

$Dose_{diet}$ = Average Daily Dose of COPC via ingestion of food (mg/kg BW/day)
TRV_{diet} = Toxicity reference value for dietary exposure (mg/kg BW/day)

The five dietary media evaluated in the SERA are ingestion of benthic invertebrates, fish, plants, earthworms, and small mammals. The results for each dietary item are presented in the following subsections.

7.5.5.1 Benthic Invertebrates

The HI values for each representative wildlife species (the mallard duck) consuming benthic invertebrates for each exposure area are presented as a range in the following text table using both NOAEL and LOAEL TRVs (Table 6-8). The detailed HQ_{diet} values calculated for each COPC are provided in Appendix E.

Receptor	Hazard Indices for Benthic Invertebrate Ingestion			
	Silver Creek - upstream	Silver Creek - downstream	Wetlands Area	South Diversion Ditch
Mallard Duck	1,000 to 6,000	400 to 2,000	200 to 2,000	400 to 3,000

The HI values for the mallard are greater than one within all exposure areas with the highest risks predicted for upstream Silver Creek. It is important to note that benthic tissue concentrations are estimated using sediment EPC values and BSAFs (Section 5.3.5.1). Actual tissue concentrations of metals in benthic invertebrates are expected to be lower. For the mallard, HQ values for most COPCs are greater than one based on both NOAEL and LOAEL TRVs. Cadmium, copper, lead and zinc appear contribute to the majority of the predicted risk (Figure 7-18).

7.5.5.2 Fish

The HI values for each representative wildlife species (the belted kingfisher and mink) consuming fish for each exposure area are presented as a range in the following text table using both NOAEL and LOAEL TRVs (Table 6-8). The detailed HQ_{diet} values calculated for each COPC are provided in Appendix E.

Receptor	Hazard Indices for Fish Ingestion			
	Silver Creek - upstream	Silver Creek - downstream	Wetlands Area	South Diversion Ditch
Belted Kingfisher	10,000 to 30,000	4,000 to 8,000	1,000 to 4,000	3,000 to 8,000
Mink	20,000 to 50,000	5,000 to 10,000	2,000 to 6,000	4,000 to 10,000

The HI values for the belted kingfisher and mink are greater than one within all exposure areas with the highest risks predicted for upstream Silver Creek. Aluminum, arsenic, lead and zinc appear to be contributing to the majority of the predicted risk.. Similarly for the mink, HQ values for most COPCs are greater than one, with antimony and lead (maximum HQs of 8,000 and 10,000), contributing most to the total HI (Figure 7-19). It is important to note that fish tissue concentrations are estimated using sediment EPC values and BSAFs (Section 5.3.5.1). Actual tissue concentrations of metals in fish are expected to be lower.

7.5.5.3 Plants

The HI values for each representative wildlife species (deer mouse and Greater-sage grouse) consuming terrestrial plants for each exposure area (background soils, off-impoundment soils, on-impoundment soils are presented as a range in the following text table using both NOAEL and LOAEL TRVs (Table 6-8). The detailed HQ_{diet} values calculated for each COPC are provided in Appendix E.

Receptor	Hazard Indices for Plant Ingestion			
	Background Soils	Off-Impoundment Soils	On-Impoundment Soils	Tailings
Deer Mouse	<1 to 3	3 to 6	2 to 5	20 to 40
Greater-Sage Grouse	all < 1	<1 to 2	all < 1	3 to 9

The HI values for the deer mouse are greater than one within all exposure areas with the highest risks predicted for exposure to plants growing on tailings followed by off-impoundment and on-impoundment soils. Risks to the Greater-sage grouse are predicted to be lower than those for the deer mouse. Within the background and on-impoundment soils exposure areas, all HI values are less than one. Within the off-impoundment and tailings exposure areas the HI values are greater than 1 but no individual HQ value is greater than one.

For both off-impoundment and on-impoundment soils, lead concentrations in plants are the primary risk drivers (Figure 7-20). For tailings, cadmium, lead, selenium and zinc concentrations in plants are the risk drivers. In interpreting the HI values, It is important to note that plant tissue concentrations are estimated using soil EPC values and bioaccumulation factors or models (Section 5.3.5.2). Actual tissue concentrations of metals in plants may be lower or higher.

7.5.5.4 Earthworms

The HI values for each representative wildlife species (American Robin and Masked Shrew) consuming earthworms for each exposure area (background soils, off-impoundment soils, on-impoundment soils are presented as a range in the following text table using both NOAEL and LOAEL TRVs (Table 6-8). The detailed HQ_{diet} values calculated for each COPC are provided in Appendix E.

Receptor	Hazard Indices for Earthworm Ingestion			
	Background Soils	Off-Impoundment Soils	On-Impoundment Soils	Site Tailings
American Robin	30 to 100	100 to 900	70 to 300	500 to 3,000
Masked Shrew	200 to 600	1,000 to 4,000	700 to 2,000	6,000 to 20,000

The HI values for the American robin and the masked shrew are greater than one within all exposure areas with the highest risks predicted for ingestion of earthworms from tailings followed by off-impoundment and on-impoundment soils and then background. Risks predicted for the masked shrew are approximately 10-fold higher than those for the American robin. For both off-impoundment and on-impoundment soils, ingestion of lead concentrations in earthworms is the primary risk drivers (Figure 7-21). For tailings, ingestion of cadmium and lead in earthworm tissues are the primary risk drivers. It is important to note that plant tissue concentrations are estimated using soil EPC values and bioaccumulation factors or models (Section 5.3.5.3). Actual tissue concentrations of metals in earthworm tissues is unknown and may be lower or higher than the estimates used to evaluate risks..

7.5.5.5 Small Mammals

The HI values for each representative wildlife species (American kestrel and red fox) consuming small mammals for each exposure area (background soils, off-impoundment soils, on-impoundment soils are presented as a range in the following text table using both NOAEL and LOAEL TRVs (Table 6-8). The detailed HQ_{diet} values calculated for each COPC are provided in Appendix E.

Receptor	Hazard Indices for Small Mammal Ingestion			
	Background Soils	Off-Impoundment Soils	On-Impoundment Soils	Site Tailings
American Kestrel	4 to 10	10 to 90	6 to 20	20 to 200
Red Fox	<1 to 3	5 to 9	3 to 5	10 to 20

The HI values for the American kestrel and red fox are greater than one within all exposure areas with the highest risks predicted for ingestion of small mammals from the tailings exposure area followed by off-impoundment and on-impoundment soils and then background. Risks predicted for the American kestrel are approximately 10-fold higher than those for the red fox. For both off-impoundment and on-impoundment soils, ingestion of cadmium and lead in small mammals are the primary risk drivers (Figure 7-22). For tailings, ingestion of cadmium, lead and selenium in small mammal tissues are the primary risk drivers. It is important to note that small mammal tissue concentrations are estimated using soil EPC values and bioaccumulation factors or models (Section 5.3.5.4). Actual tissue concentrations of metals in small mammals is unknown and may be lower or higher than the estimates used to evaluate risks.

7.5.6 Wildlife Summary

The results of the SERA indicate a potential for adverse effects to wildlife receptors associated with the ingestion of metals in surface water, sediment, soil, benthic invertebrates, fish, plants, earthworms and small mammals. Based on the evaluation of the HI values in the previous subsections the following is summarized concerning potential risks for wildlife:

- ***Ingestion of Surface Water.*** Risks are predicted only for upstream Silver Creek for the masked shrew and Greater-Sage grouse as a result of ingestion of lead in surface water. All other HI values for wildlife are less than one and below a level of concern.

- ***Ingestion of Seep Water***. Risks are predicted only for upgradient groundwater for the masked shrew ingesting lead. All other HI values for wildlife are less than one and below a level of concern.

- ***Ingestion of Sediment.*** Total HIs for the mallard, belted kingfisher and mink from the incidental ingestion of sediment are greater than one for all locations in Silver Creek, the south diversion ditch, and the wetlands area. HI values are highest for upstream Silver Creek followed by downstream Silver Creek, the wetlands area, and the south diversion ditch. Lead and aluminum contribute the most to risk for avian receptors while antimony and lead contribute the most to predicted risks for the mink.

- ***Ingestion of Soil.*** Total HIs are greater than one for all avian and mammalian representative species for on-impoundment soils and tailings. HI values are also greater than one for some species for off-impoundment soils. Aluminum and lead contributes the most to predicted risks for on-impoundment soils while lead is the primary contributor to risks for off-impoundment soils. In background soils, arsenic, barium and lead contribute the most to predicted risks for the American robin and the masked shrew. Risks for exposure to On-impoundment soils is higher than Off-Impoundment soils. The lowest overall risks are predicted for representative wildlife species exposed to soils at areas identified as background.

- Ingestion of Benthic Invertebrates. Total HI values for the mallard are greater than one for all exposure areas. The primary contributors to risk are cadmium, lead and zinc. Risks (based on relative HI values) are highest for upstream Silver Creek followed by the south diversion ditch and the wetlands area and downstream Silver Creek.

- ***Ingestion of Fish***. Total HI values for the belted kingfisher and mink are greater than one for all exposure areas. Aluminum, antimony, lead and selenium contribute most to the predicted risks for the mink. For the belted kingfisher, aluminum, arsenic, cadmium and zinc contribute the most to predicted risks.

- ***Ingestion of Plants.*** HI values are greater than one for both species evaluated (the Greater-sage grouse and the deer mouse) for some exposure areas (off-impoundment soils and tailings). Lead and selenium are the primary contributors to the predicted risks. Risks (based on relative HI values) are highest for tailings followed by off and on-impoundment soils and background.

- ***Ingestion of Earthworms.*** HI values for both representative species are greater than one for all exposure areas. Lead and mercury are the primary contributors to the predicted risks. Risks (based on relative HI values) are highest for tailings followed by off-impoundment soils, on-impoundment soils and background.

- ***Ingestion of Small Mammals.*** Total HI values for both species (the American kestrel and red fox) are greater than one for exposure areas. Cadmium, lead and selenium are the primary contributors to the predicted risks.

7.6 Summary of SERA Results

The primary findings of the SERA for the RFT Site are summarized in Table 7-11. These findings are used to identify the data need to complete a more detailed analyses of ecological risks. These data gaps and recommended data to fill them are discussed further in Section 9.0.

8.0 UNCERTAINTIES

The HQ values presented should not be interpreted as highly precise estimates of actual risk of ecological effects. Quantitative evaluation of ecological risks is limited by uncertainty (lack of knowledge) regarding a number of important data, exposure, toxicity, and risk factors. This lack of knowledge is usually circumvented by making estimates based on whatever limited data are available, or by making assumptions based on professional judgement when no reliable data are available. Because of these assumptions and estimates, the results of the risk calculations are themselves uncertain, and it is important for risk managers and the public to keep this in mind when interpreting the results of a risk assessment.

The USEPA recommends that an ecological risk assessment include a discussion of uncertainties that influence the interpretation of the results (USEPA, 1997). This section summarizes the key sources of uncertainty influencing the results of the SERA. The discussion of uncertainties is organized according to the components of the SERA. A tabular summary is provided in Table 8-1.

8.1 Uncertainties in Problem Formulation

8.1.1 Selection of Receptors

Risks to wildlife are assessed for a small subset of the species likely to be present at the RFT Site. The representative wildlife species selected for quantitative evaluation represent a range of taxonomic groups and life history types. An effort was made to select species representing the full range of possible exposures present in the area. This analyses, however, was completed in the absence of site-specific information concerning wildlife species and habitat present at the RFT site. These species may not, however, represent the full range of sensitivities present. The species selected may be either more or less sensitive to contaminant exposures than typical species located within the area. In particular, the relative sensitivities of reptiles as compared to birds, mammals, or amphibians are unknown. It is assumed that the risks to these organisms are at least qualitatively similar to risks to birds, mammals, and amphibians. Reptile species were not selected, as toxicity data for ingestion exposures to contaminants is limited.

8.1.2 Selection of Exposure Pathways

The exposure pathways selected for evaluation in the SERA are not inclusive of all potential exposure pathways for all ecological receptors. It is necessary to select a subset of possible exposure pathways for two primary reasons: 1) There is not enough information available to evaluate an exposure pathway and 2) it is necessary to limit the effort required when completing the assessment. For the SERA, the pathways selected for analyses are believed to represent those where contaminant exposures are highest.

8.1.3 Exposure Pathways that could not be Evaluated

Certain exposure pathways could not be evaluated in the SERA including:

- Exposures for amphibians to COPCs in soil and dust via inhalation, direct contact or ingestion could not be evaluated due to a lack of dose-response information for these exposure pathways as well as a lack of exposure parameters necessary to estimate COPC doses.

- Exposures for amphibians to COPCs in sediment, surface water, seeps and the aquatic food chain via ingestion could not be evaluated due to a lack of dose-response information for these exposure pathways as well as a lack of exposure parameters necessary to estimate COPC doses.

8.1.4 Selection of Ecological Contaminants of Potential Concern (COPCs)

The methodology used to select COPCs in the SERA may result in a number of uncertainties. These uncertainties are outlined below.

- Risk evaluation is only completed for those contaminants that have been identified as COPCs through the screening process. Not evaluating contaminants that are not identified as COPCs, but for which data are available may result in a slight underestimate of risk.

- Contaminants that are not detected, but for which the detection limit exceeds a level of concern are identified as a source of uncertainty. USEPA (1989) suggests eliminating those contaminants that have not been detected in any samples of a particular medium, although the detection limits exceed levels of ecological concern. It is assumed that these contaminants would only have a negligible effect on risk levels and would not likely result in a significant underestimate of risk.

- Contaminants with a detection frequency less than five percent are identified as a source of uncertainty. It is assumed that the infrequent presence of these contaminants would have only a negligible effect on risk levels and would not likely result in a significant underestimate of risk.

- Although a reference (background) comparison screening step for inorganics is identified in the COPC selection process, this reference comparison is not effectively used in the selection process as the sample sizes for all reference data sets are too small (sample size less than five) or are not representative of background.

8.2 Uncertainties in Exposure Assessment

8.2.1 Environmental Concentrations

In the exposure assessment, the desired input parameter is the true mean concentration of a contaminant within a medium, averaged over the area where exposure occurs. For the RFT Site, environmental data were not obtained in a truly random fashion and are likely to be biased toward areas of maximum contamination. In addition, the available data sets for the SERA are currently incomplete, which provides a limited means for deriving reliable exposure estimates.

The techniques used for data sampling and analysis, and methods used for selecting contaminants for evaluation in the risk assessment may result in a number of uncertainties. These uncertainties are itemized below.

- Analyzed samples may not represent the actual levels of contaminants at the RFT Site. This may result in either an over- or underestimate of risk.
- Systematic or random errors in the contaminant analyses may yield erroneous data. These types of errors may result in a slight over- or underestimate of risk.
- The UCL95 or maximum concentrations are used to represent levels of exposure for terrestrial wildlife. Use of these upper bound concentrations provides a conservative estimate of average RFT Site concentrations; actual exposures may, however, be lower or higher.

8.2.2 Lack of Data on Extent of Contamination in Seeps

Analytical data for the seep located at the base on the main embankment are not available. Aquatic and terrestrial receptors may be exposed to contamination in the seeps via direct contact or ingestion. Groundwater data from several monitoring wells near the seep were used to evaluate possible risks associated with the seeps. Use of the groundwater data may result in either an under- or overestimation of risks.

8.2.3 Limited Data on the Extent of Contamination in the Wetlands

Surface water and sediment data for the wetlands area located west of the main embankment are limited. Previous reports indicate that the wetland sediments are tailings (ESE, 1993). Aquatic and terrestrial wildlife may be exposed to contamination in sediment and surface water in the wetlands by direct ingestion or the ingestion of food. The SERA analyses is limited to 4 sediment samples from the wetland. Use of these limited data may result in either an under- or overestimation of risks.

8.2.4 Limited Analyses of Soil Samples

Soil samples (either on impoundment or off impoundment) were analyzed for all metals in only 20% of the samples collected. All samples were analyzed for both arsenic and lead. This limits the data set for soils for ecological risk analyses and may result in either an under or overestimation of risks as lead and arsenic are not the only COPCs of concern for ecological receptors to soil contamination and do not represent the COPCs associated with the highest risk.

8.2.5 Lack of Data on Extent of Contamination in Biological Tissues

The most direct way to assess dietary exposures for ecological receptors is to measure tissue burdens of COPCs. This measurement eliminates uncertainties associated with estimating the uptake and transfer of contamination from soils, surface water, sediments, and seeps into either the aquatic or terrestrial food chain. Currently, data are not available on tissue concentrations of COPCs in any biological tissues at the

RFT Site. The lack of data may result in either an under- or overestimation of risks. Collection of data on tissue burdens of COPCs would reduce the uncertainties. Collection of tissue samples concurrently with soil and/or sediment samples would provide correlation of tissue burdens with environmental concentrations.

8.2.6 Wildlife Exposure Factors

Ingestion-related exposure assumptions for wildlife are based on literature-derived information concerning average body sizes, diet compositions, consumption rates, and metabolic rates. Much of this information is derived from laboratory-reared animals and may not be representative of feral organisms. Moreover, the actual diet composition of an organism will vary daily and seasonally. These uncertainties could either under- or overestimation the actual exposures of wildlife to COPCs in water, sediment, soil and diet.

8.2.7 Estimation of Doses for Terrestrial Wildlife

Estimates of wildlife exposure due to incidental sediment ingestion conservatively assume that 100% of the metals present are biologically available (100% will be ingested and absorbed in the gut). This assumption likely overestimates contaminant doses to wildlife, as absorption efficiencies for most metals are less than 100%.

It is also assumed in the calculation of contaminant doses for wildlife that contaminants present in environmental media have the same bioavailability as contaminants in laboratory test media. This assumption is conservative because laboratory testing purposely includes dosing regimes (method of administration and contaminant form) to insure a uniform and maximum uptake of contaminants.

8.3 Uncertainties in Effects Assessment

8.3.1 General Use of Toxicity Screening Benchmarks

The literature-derived data used to identify toxicity benchmarks contain uncertainties related to the application of generic data to site-specific conditions. The toxicity benchmarks identified for the SERA are based on data from a wide range of sites and conditions, many of which may be quite different from the conditions at the RFT Site. These literature-derived values are expected to be less accurate than site-specific data, but the magnitude and direction of any errors introduced by their use are unknown.

There are often important site-specific factors that may tend to modify (often decrease) the toxicity of metals in surface water, sediments and soil. In general, these site-specific factors are referred to as "bioavailability" factors. For example, metals in surface water may be bound to soluble organic materials that reduce the tendency for the metal to bind to respiratory structures of fish or benthic organisms. Similarly, the presence of organic matter in soil, along with other substances, may have a significant influence on actual toxicity. One of the best ways for investigating the importance of such factors is to perform toxicity tests using site-specific media, either by in-situ assays or laboratory bioassays. The results of site-specific toxicity studies can significantly increase the accuracy of the ERA process.

8.3.2 General Use of Sediment Toxicity Benchmarks

A potential limitation to the use of sediment screening benchmarks is that not all of the metals in the bulk sediment may be available for dissolution into the pore water. Studies by a number of researchers have found that the tendency of certain metals in sediment to dissolve into the pore water is determined in large part by the amount of sulfide present in the sediment (Hansen et al., 1996; Ankley, 1996; Ankley et al., 1996). This is because divalent cations of heavy metals such as cadmium, copper, lead, zinc, and nickel form highly insoluble complexes with sulfides. Thus, if the sediment contains sufficient sulfide to complex the metals, then dissolution into pore water and resultant toxicity to benthic organisms is not expected (Hansen et al., 1996; Ankley, 1996; Ankley et al., 1996).

Based on these considerations, one method for evaluation of site-specific effects and risks for benthic invertebrates to metals in sediments is to measure the amount of acid-extractable cadmium, copper, lead, zinc, nickel, and mercury (these are referred to as Simultaneously Extractable Metals, or SEM). The SEM is compared to the simultaneously measured level of Acid Volatile Sulfide (AVS). If the measured level of SEM (mmol/g) is the same or less than AVS (mmol/g), then it is expected that the metals in sediment are not contaminantly available to partition to pore water. Thus, toxicity to benthic invertebrates is not of concern. If the concentration of SEM exceeds the concentration of AVS, then there is a possibility of metal release to pore water and possible toxicity. An exceedance of AVS by SEM is not proof that toxicity will occur, especially if the exceedance is fairly small (e.g., less than approximately 5 mmol/g) (Hansen et al. 1996). This is due to the observation that other materials in sediment (e.g., organic carbon) may also bind metals (Mahony et al., 1996; Hansen et al., 1996).

Another direct method for measuring exposure and assessing risks for sediment-dwelling benthic invertebrates is to measure the concentration of metals in the sediment pore water and to compare those measurements to appropriate screening benchmarks or to complete toxicity testing in the laboratory exposing test organisms to site whole phase sediment samples.

8.3.3 Absence of Toxicity Benchmarks

Toxicity screening benchmarks were not available for all COPCs. A summary of these unavailable benchmarks is provided below. The lack of these benchmarks may result in the under-estimation of potential risks.

Absence of Toxicity Screening Benchmarks	
Type of Benchmark	**COPC**
Ambient Water Quality Criteria for Aquatic Receptors for Direct Contact with Water	Antimony, barium, beryllium, boron, calcium, cobalt, lithium, magnesium, manganese, molybdenum, potassium, sodium, strontium, thallium or vanadium Chronic Criteria Only: iron Acute Criteria Only: silver
Toxicity Benchmarks for Amphibians for Direct Contact Exposures with COPCs in surface water or seep water.	Boron, thallium, vanadium, cobalt, chromium, manganese,
Toxicity Benchmarks for Benthic Invertebrates for Direct Contact Exposures to COPCs in Sediment	Barium, beryllium, cobalt, selenium, thallium, vanadium
Toxicity Benchmarks for Soil Fauna for Direct Contact Exposures to COPCs in Soil	Antimony

8.3.4 Absence of Wildlife TRVs

Avian toxicity data for antimony and silver were not available in either of the secondary review sources (Sample et al., 1996 and Engineering Field Activity West, 1998). Quantitative assessments of risks to avian species related to exposure to antimony and thallium were not performed. This uncertainty results in an underestimation of risks.

8.3.5 Derivation of Wildlife TRVs

Toxicity information for many contaminants is often limited. Consequently, there are varying degrees of uncertainty associated with the wildlife toxicity reference values. These uncertainties may result in an over- or underestimate of risk. Sources of uncertainty associated with toxicity values are listed below.

- Uncertainty in toxicity factors arises from the lack of knowledge on the potential interactive effects of different contaminants. Most TRV values are derived from studies of the adverse effects of a single contaminant. However, exposures to ecological receptors usually involve multiple contaminants, raising the possibility that synergistic or antagonistic interactions might occur. This sort of interaction is of particular importance with regard to metals, since it is known that the absorption and toxicity of some metals interact in complex ways. However, data are not adequate to permit any quantitative adjustment in toxicity values or risk calculations based on inter-contaminant interactions. This uncertainty may result in over- or underestimates of risk.

- Using dose-response information from effects observed at high doses to predict the adverse effects associated with lower doses may result in a slight to moderate overestimate of risk.

9.0 DATA GAPS AND RECOMMENDATIONS

The following sections describe the data gaps present in the SERA that need to be filled to complete a quantification of ecological risks. The data gaps are discussed according to potential ecological receptor and exposure medium. The potential exposure media include surface water, sediments, soils and diet. The results of the SERA are summarized in Table 7-11 and are used to discuss data gaps which are described in Table 9-1. The data gaps and recommendations are segregated into analytical data, toxicological data and biological data requirements. Each is discussed with regard to exposure areas on the RFT site including silver creek, the wetland and embankment area, the diversion ditches, on-impoundment soils and off-impoundment soils.

9.1 Silver Creek

Upon examination of the HQ values calculated and presented as Figure 7-1, 7-2 and 7-5 it evident that the surface waters and sediments of Silver Creek are more contaminated with metals upstream of the RFT site compared to downstream. The SERA results show there are risks for aquatic life and terrestrial wildlife for Silver Creek both upstream and downstream of the RFT Site. However, it is concluded based on the SERA information that the RFT Site is not contributing to increased risks in Silver Creek based on both the available surface water and sediment data. Based on this conclusion, further sampling and risk evaluation of Silver Creek in relation to the RFT Site not recommended.

This recommendation, however, is based on the assumption that the risks occurring in Silver Creek will be addressed as part of the risk evaluation of the upstream sources and that any decisions concerning actions in Silver Creek will consider possible influences of future contaminant transport from RFT into Silver Creek. For example, if the metals present in sediments and/or surface water are reduced in Silver Creek (as a result of clean up activities) then the possible discharges from the RFT Site could decontaminate the surface water or sediments and/or become the dominant influence on metal loading.

This recommendation is also exclusive of the reported flood plains tailings pile located immediately west of the tailings impoundment and covering about 6 acres along the banks of Silver Creek (USEPA, 1991). This source is reported to be located on the western side of Silver Creek about 300 feet upstream of the confluence of Silver Creek with the wetland area and extends from there for about 2500 feet upstream. The USEPA and the State of Utah both observed tailings entering Silver Creek from the flood plain tailings pile during site visits for the HRS Scoring (USEPA, 1991). According to analyses performed in 1985 and 1989, the flood plain tailings pile contains arsenic, cadmium, copper, lead, mercury, silver, and zinc (USEPA, 1991). The HRS data is excluded from the SERA as not representative of current conditions on the RFT site in the main impoundment area. Outside of the main impoundment area there could be as many as five samples from this tailings area but the locations are not known (Figure 3-1). It is also not clear from current site boundary information if this area is now part of the RFT Site. This is identified as a data gap for the baseline ERA. If the floodplain tailings are part of the RFT Site then this area needs to be further investigated and recommendations will be provided at a later date.

9.2 Wetland Area and Embankment

9.2.1 Analytical Data

There is currently no data available on the extent of contamination in the surface waters of the wetland area or the seeps at the base of the embankment. The SERA used groundwater data to screen for possible risks associated with the discharge of contaminated groundwater to the wetland. These results for aquatic receptors (Figure 7-6) and amphibians (Figure 7-9) show possible risks for both of these receptor groups associated with exposure to metals in seep water. More accurate risk estimates could be calculated if analytical data from the seeps and the surface water of the wetland were available.

It is recommended that sampling of surface water and seep water be completed to provide data for risk analyses for aquatic receptors, wildlife and amphibians. The samples should be analyzed for the Target Analyte List (TAL) metals. In addition to the analytical measurements, general water quality data should be collected including dissolved oxygen, conductivity, alkalinity, dissolved solids, total suspended solids and pH. All of these factors influence either the potential toxicity of metals or habitat quality.

Additional sediment samples are also recommended from the wetland area. The SERA results are based on evaluation of only 4 sediment samples. Additional sediment samples with concurrent measurements of metals in sediment pore water should be also be collected. The sediment samples would be analyzed for TAL metals and the pore water samples for both total and dissolved TAL metals. The pore water analytical results will be used to evaluate the potential bioavailability and toxicity of the metals in sediment.

9.2.2 Biological Data

There is currently no information available describing the type of wetlands present or habitat. This information is critical to understanding what ecological receptors (aquatic and terrestrial) are using this area of the RFT site and what the possible exposure pathways may be. The type of wetland habitat available determines use by wildlife. It is recommended that the wetland area be surveyed to identify the type of plants present as well as any signs of wildlife use. This survey would be qualitative in nature with the purpose of describing the type of habitat present. This information would then be used to identify the possible species of wildlife present.

Sampling of macroinvertebrates from the wetland area is recommended to identify what species are present within the area and may be exposed to contamination in seeps, surface water and sediments. This information will also be used to possible site-specific toxicity testing.

9.2.3 Toxicological Data

The SERA results predict that surface water, seep water and sediments in the wetland area are likely to be toxic to aquatic receptors. However, site-specific toxicity of the COPCs in these environmental media is not known and could be potentially very different from that predicted. It is recommended that site-specific toxicity testing of environmental media be considered after collection of the basic habitat information along with the goals of the overall RI/FS program. These results will reduce uncertainties in the conservative screening calculations used the SERA and can be used to identify the need for and focus remediation efforts to reduce risks.

The toxicity of the seeps to aquatic life could be directly testing using standard surface water toxicity tests with either the daphnid (*Ceriodaphnia dubia*) and/or the fathead minnow (*Pimephales promelas*). The results of these tests would provide direct evidence concerning the toxicity of the seep water and its contribution to surface water toxicity in the wetland. This of course assumes that the wetland habitat present does support aquatic receptors (including amphibians) for at least a portion of the year.

The analytical data presented in this SERA shows substantial contamination of sediments within the wetland area. ESE (1993) concluded that the sediments in the wetland were equal to tailings material. The mean PEC Quotients calculated for wetland sediments (Section 7.2.2.2) indicate that probability of observing toxicity is 100% for 3 of the 4 samples and 88% for a fourth sample. Based on the results of the habitat survey and the use of the area by aquatic and terrestrial wildlife, it may be useful to measure site-specific sediment toxicity using EPA standard whole phase sediment toxicity test protocols with either chironomids and/or the amphipod (*Hyallela azteca*). Toxicity testing of sediment pore water samples is also an option using the standard surface water toxicity testing discussed with regard to toxicity of seeps.

9.2.4 Biological Tissue Data

Risks are predicted for wildlife receptors in the SERA for ingestion of aquatic food items (fish and benthic invertebrates) based on the estimated concentrations of COPCs in these items using existing BSAF models are a conservative assumption. Ingestion of fish and benthic invertebrates contributes the most of the HI values for each representative species (Figure 9-1) compared to incidental ingestion of sediments. The models and assumptions (i.e., ratio of 1:1 between sediment to fish tissue) are conservative and likely overestimate the site-specific uptake of metals and risk.

The bioavailability and uptake of metals from surface water, sediments, and food in the aquatic environment for metals is driven by many site-specific factors. For some contaminants, in particular, mercury and selenium, uptake is not driven by concentrations in sediment and/or water but instead is driven by site-specific microbial activity that controls conversion of the metals from inorganic to organic forms. based on site-specific factors that are difficult to impossible to predict. To reduce the uncertainties in these risk estimates, it is recommended that measurements of metals concentrations be made in aquatic food items available from the wetland for terrestrial wildlife species. Decisions concerning the selection of plant and aquatic organism species for collection and analyses will be dependant on the outcome of the habitat survey.

9.3 South Diversion Ditch

[Table 9-1 complete but not text]

9.3.1 Analytical Data

Current sampling of the sediments of the South Diversion ditch is adequate for establishing extent of contamination. It may however be necessary to collect further samples for analyses concurrently with any toxicity testing, benthic invertebrate sampling, or biological tissue sampling as discussed in the next sections. Samples should be analyzed for TAL metals. Also, sampling and analyses of TAL metals in sediment pore water may be useful in understanding the bioavailability and potential toxicity of metals measured in bulk sediment samples.

9.3.2 Biological Data

Information on the type of habitat provided by the South Diversion ditch and thus its potential use by wildlife and aquatic receptors is unknown. Collection of qualitative data on vegetative cover of the South Diversion Ditch area is recommended to evaluate possible used by wildlife and aquatic receptors. Also recommended is a qualitative sampling of the diversion ditch (concurrently with sediment and sediment pore water samples) to identify the presence or absence of macroinvertebrates and the possible use of the ditch by fish species. Species will be identified to lowest taxonomic level possible.

9.3.3 Toxicological Data

[Table complete but not text]

9.3.4 Biological Tissue Data

[Table complete but not text]

9.4 On and Off-Impoundment Soils

[Table complete but not text]

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Figures

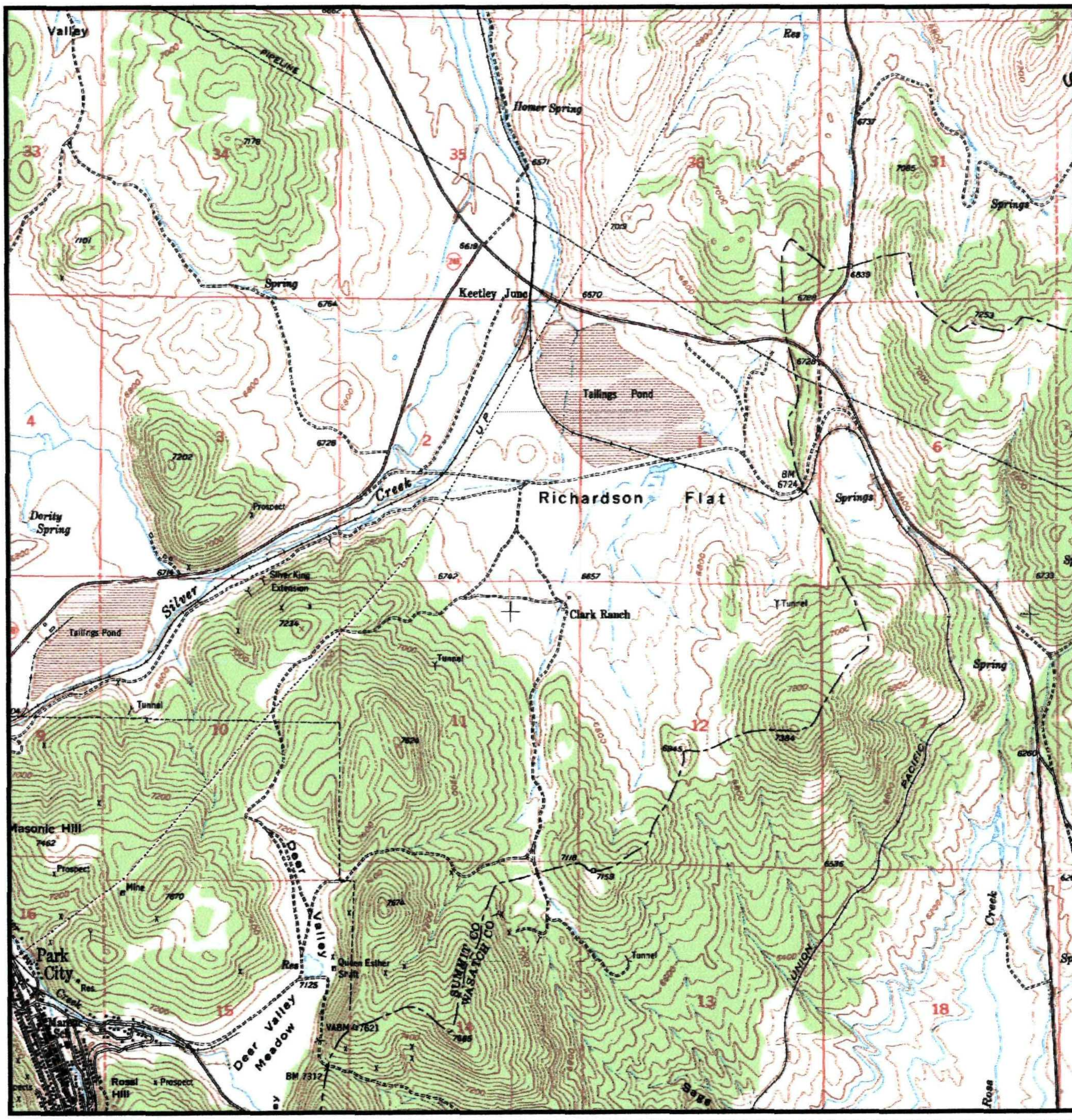


Figure 1 - 1
Richardson Flat Tailings Site Location Map

Screening Ecological Risk Assessment for Richardson Flat Tailings

Screening Problem Formulation

- ✓ Identify sources of contamination
- ✓ Identify ecological receptors (aquatic and terrestrial)
- ✓ Identify migration pathways (runoff, leaching, etc.) from source(s) to exposure medium (surface water, seeps, sediment, soil, aquatic and terrestrial food chain) for ecological receptors
- ✓ Identify exposure pathways (ingestion, dermal contact, etc.) for ecological receptors
- ✓ Construct Site Conceptual Model (SCM) that visually depicts the above.
- ✓ Select Contaminants of Potential Concern (COPCs)
- ✓ Identify goals and endpoints for the Screening Ecological Risk Assessment (SERA)

Exposure Assessment

Exposure Point Concentrations (EPCs) are identified for each receptor (aquatic receptors, terrestrial plants, soil invertebrates and wildlife), for each COPC, for each medium of concern:

Aquatic Receptors - EPCs in surface water, sediment and seeps at each sampling location.

Terrestrial Plants and Soil Invertebrates - EPCs in soils for four exposure units (background, off-impoundment, on-impoundment and tailings)

Wildlife -EPCs in surface water, sediment, seeps and food items for each of exposure unit. The concentrations are converted to dose (mg/kg BW/day).

Effects Assessment

Toxicity screening benchmarks are identified for each COPC for each medium of concern:

Aquatic Receptors and Surface Water/Seeps - Acute and Chronic Ambient Water Quality Criteria (AWQC) for each sampling station based on measured hardness, if applicable.

Aquatic receptors and Sediment - Toxicity effects range (low and high) benchmarks.

Terrestrial Plants and Soil Invertebrates –Toxicity effects range (low and high) benchmarks.

Wildlife – Doses of each COPC (mg/kg BW/day) associated with no observed adverse effects (NOAEL) and lowest observed adverse effects (LOAEL).

Screening Risk Characterization

Hazard Quotient (HQ) = Exposure Point Concentration (EPC) / toxicity benchmark

Aquatic Receptors and SurfaceWater/Seeps: HQs calculated for each sampling location; based on total and dissolved concentrations compared to acute and chronic AWQCs.

Aquatic Receptors and Sediment: HQs calculated for each sampling location using the range of toxicity benchmarks.

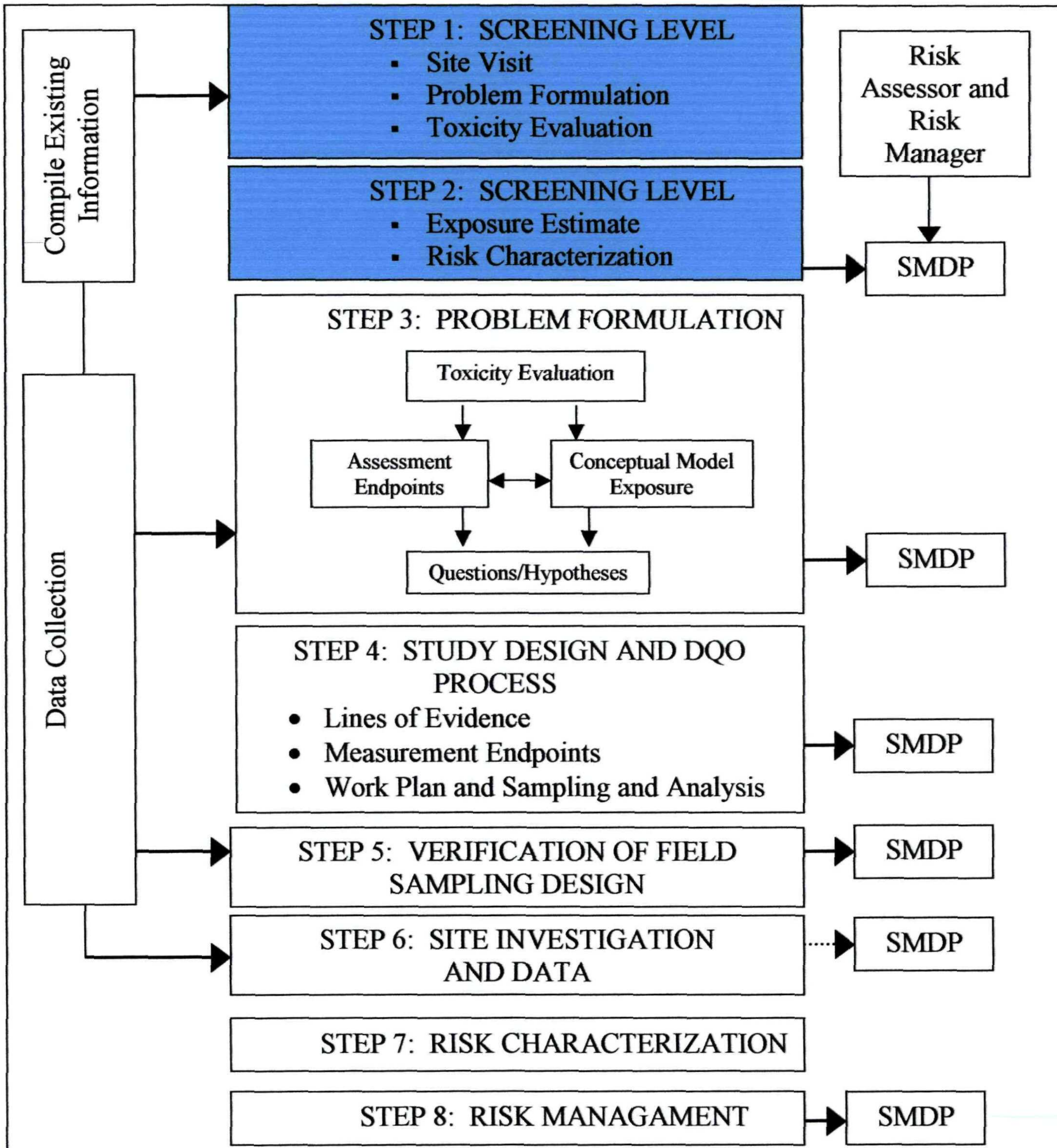
Terrestrial Plants and Soil Invertebrates - HQs calculated for each sampling location using the range of toxicity benchmarks.

Wildlife: HQs calculated separately for ingestion of surface water, sediment, seeps and food items for each exposure unit; concentrations compared to NOAEL and LOAEL toxicity reference values (TRVs).

Data Gaps and Recommendations

Figure 1-2
General Process for the Screening Ecological Risk Assessment (SERA)

Screening Ecological Risk Assessment for Richardson Flat Tailings



SMDP = Scientific Management Decision Point

Figure 1-3
Eight Step Process Recommended in Ecological Risk Assessment Guidance for Superfund (ERAGs) (USEPA, 1997)

Screening Level Ecological Risk Assessment for Richardson Flat Tailings

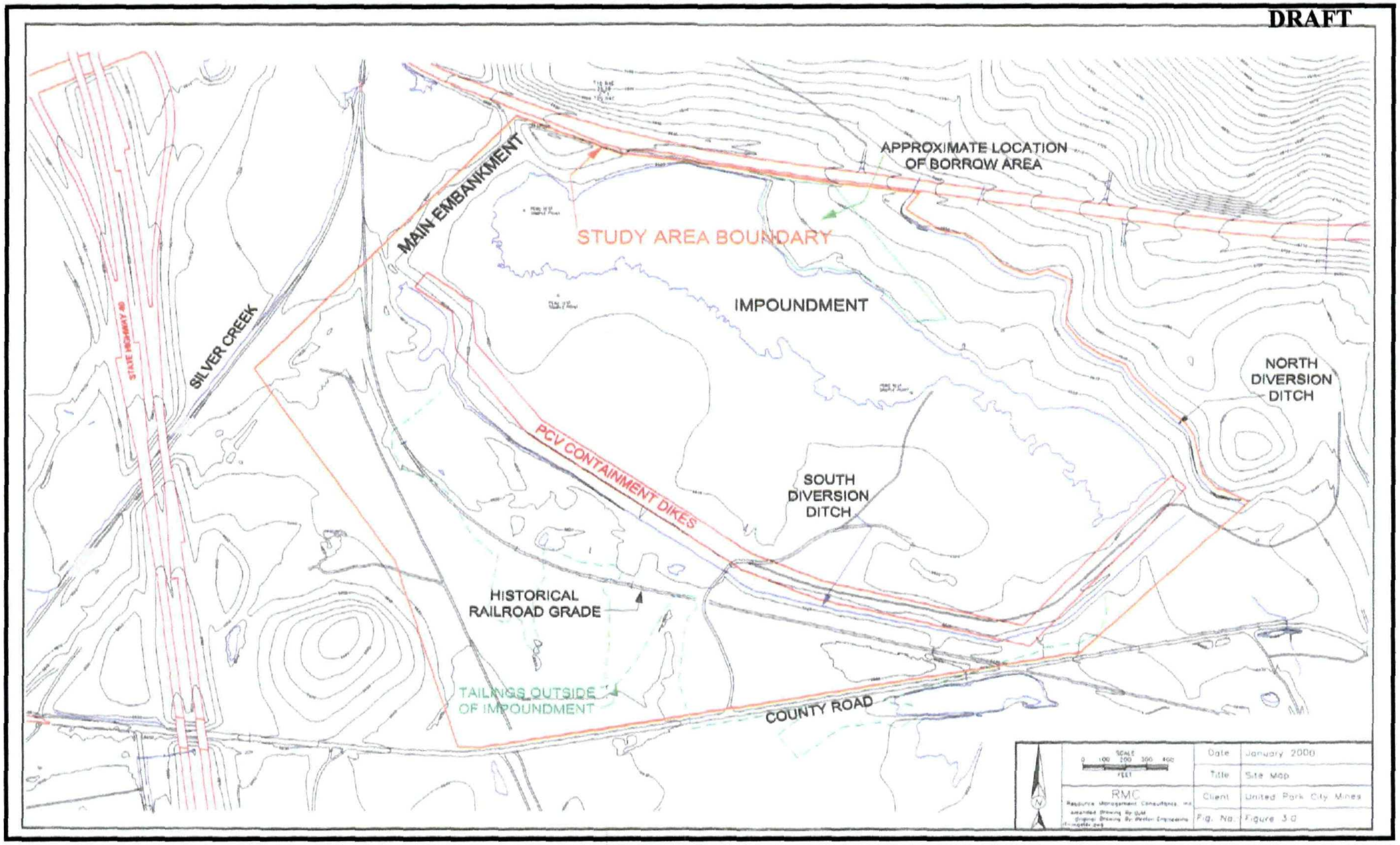


Figure 2-1
Richardson Flat Tailings Site Map

Screening Ecological Risk Assessment for Richardson Flat Tailings

Source: Resource Management Consultants, 2000 (RI/FS Workplan)

DRAFT

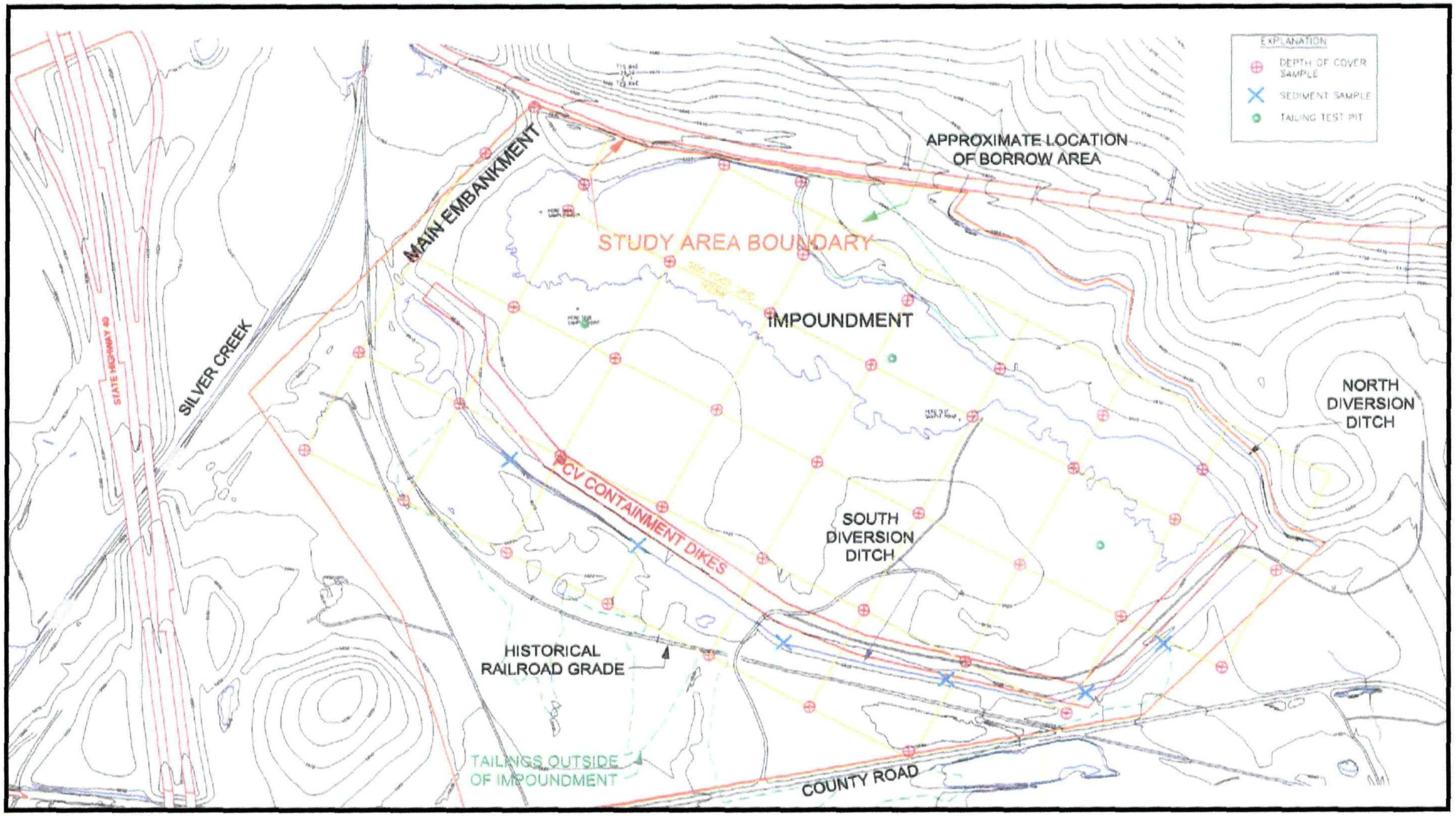


Figure 3-1
RMC On-Impoundment
Soil, Tailings, & Sediment Sampling Locations

Screening Ecological Risk Assessment for Richardson Flat Tailings

Fig 3-1 RMC OnSite Locations.ppt

Source: RMC, 2000a [RI/FS Workplan]

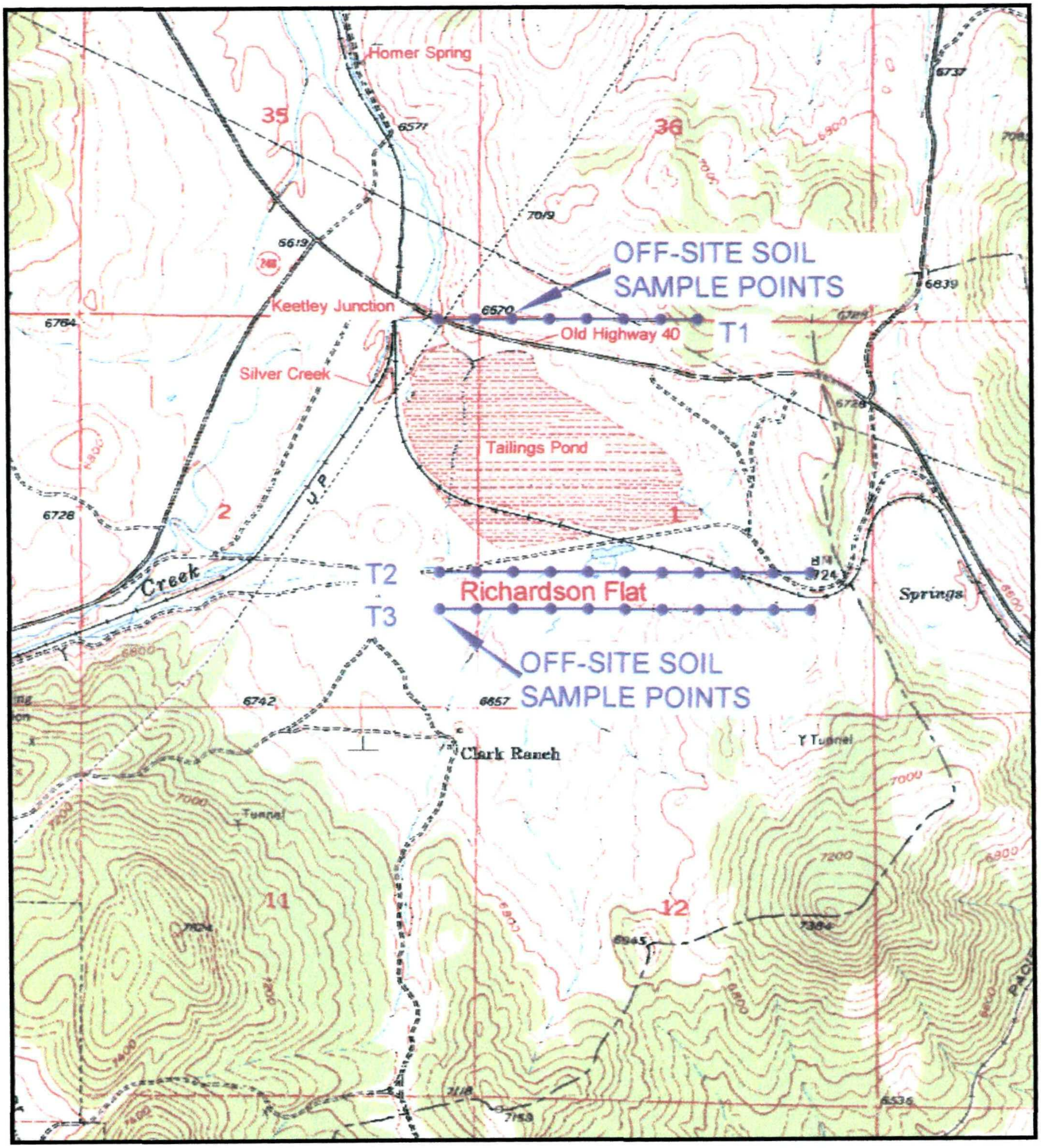


Figure 3-2
RMC Off-Impoundment Soil Sampling Locations

Screening Ecological Risk Assessment for Richardson Flat Tailings

Source: Resource Management Consultants, 2000a [RI/FS Workplan]

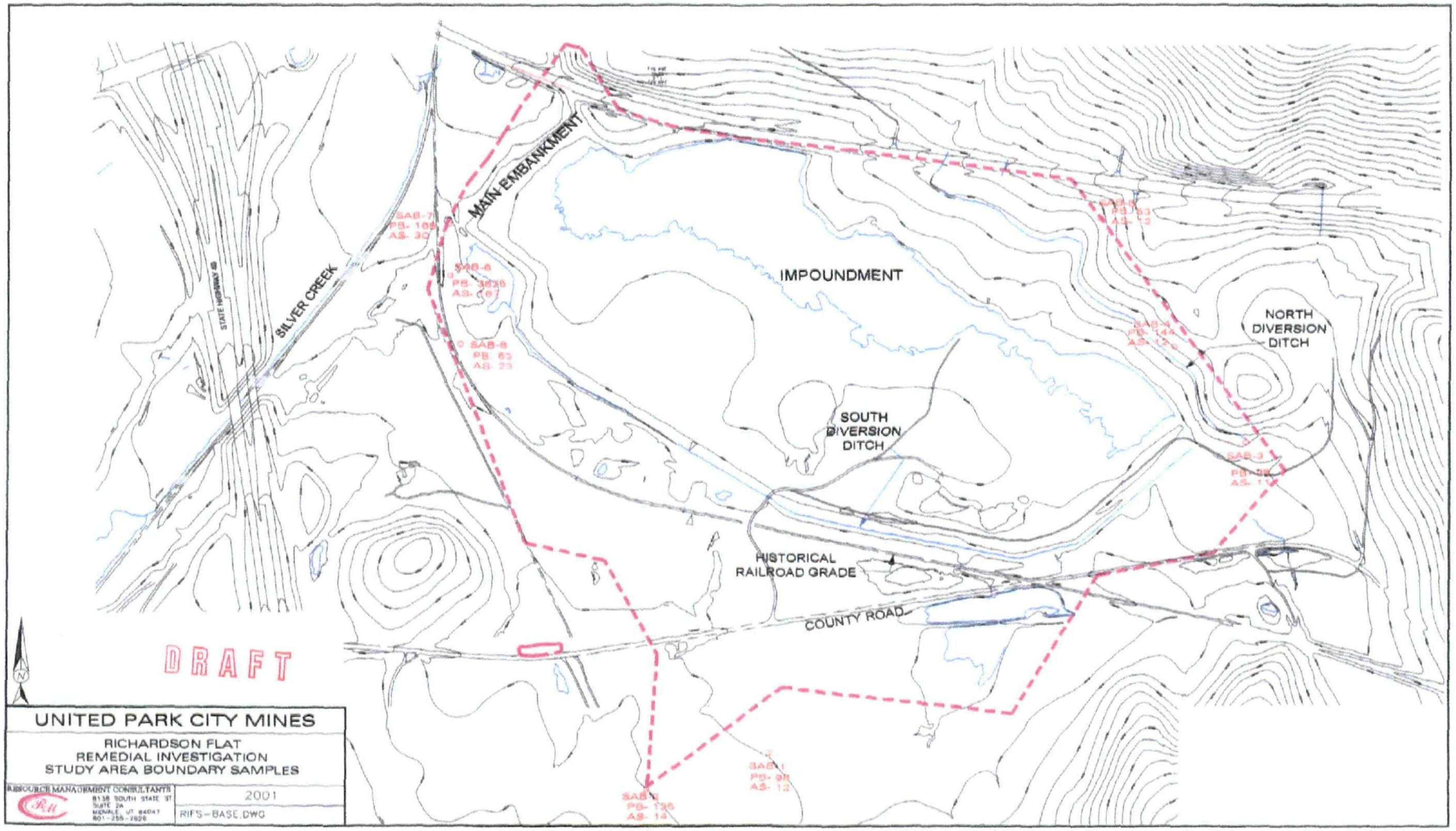


Figure 3-3
RMC Study Area Boundary Soil Sampling Locations

Screening Ecological Risk Assessment for Richardson Flat Tailings

Source: RMC, 2001 [DRAFT RI/FS]

DRAFT

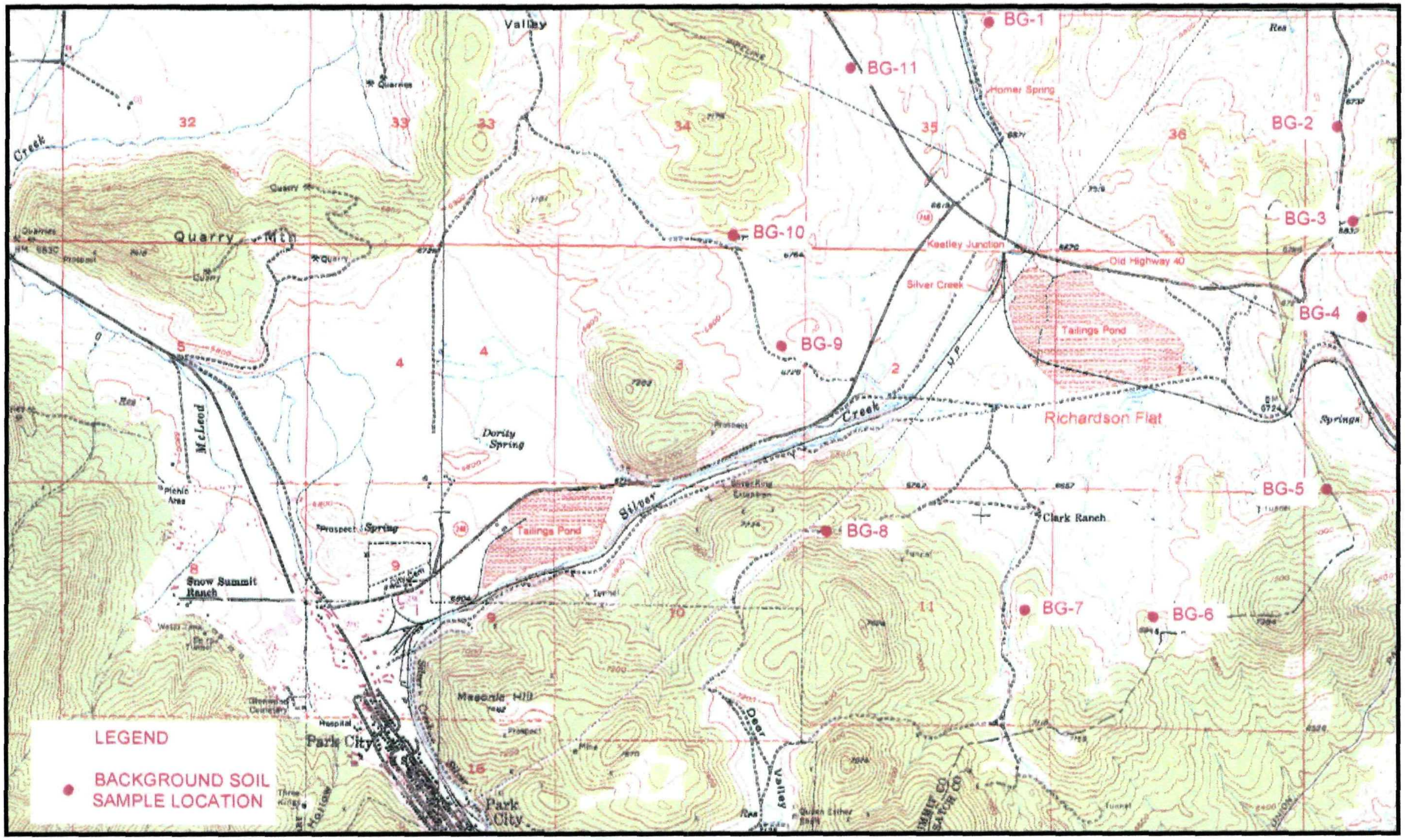


Figure 3-4
RMC Background Soil Sampling Locations

Screening Ecological Risk Assessment for Richardson Flat Tailings

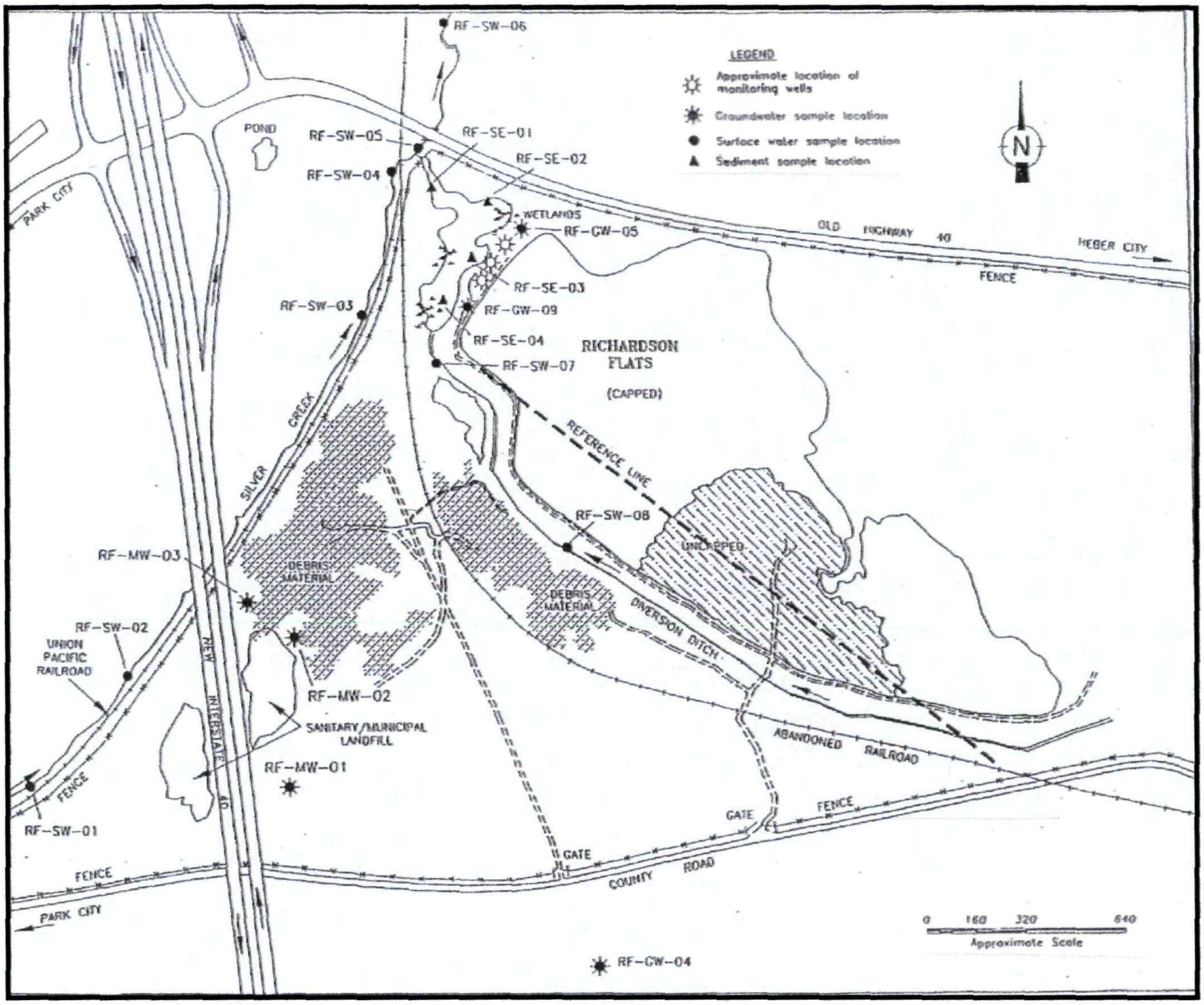


Figure 3-5
Ecology & Environment (1993) Surface Water and Sediment Sampling Locations

Screening Ecological Risk Assessment for Richardson Flat Tailings

Source: E&E, 1993 – Figure 1

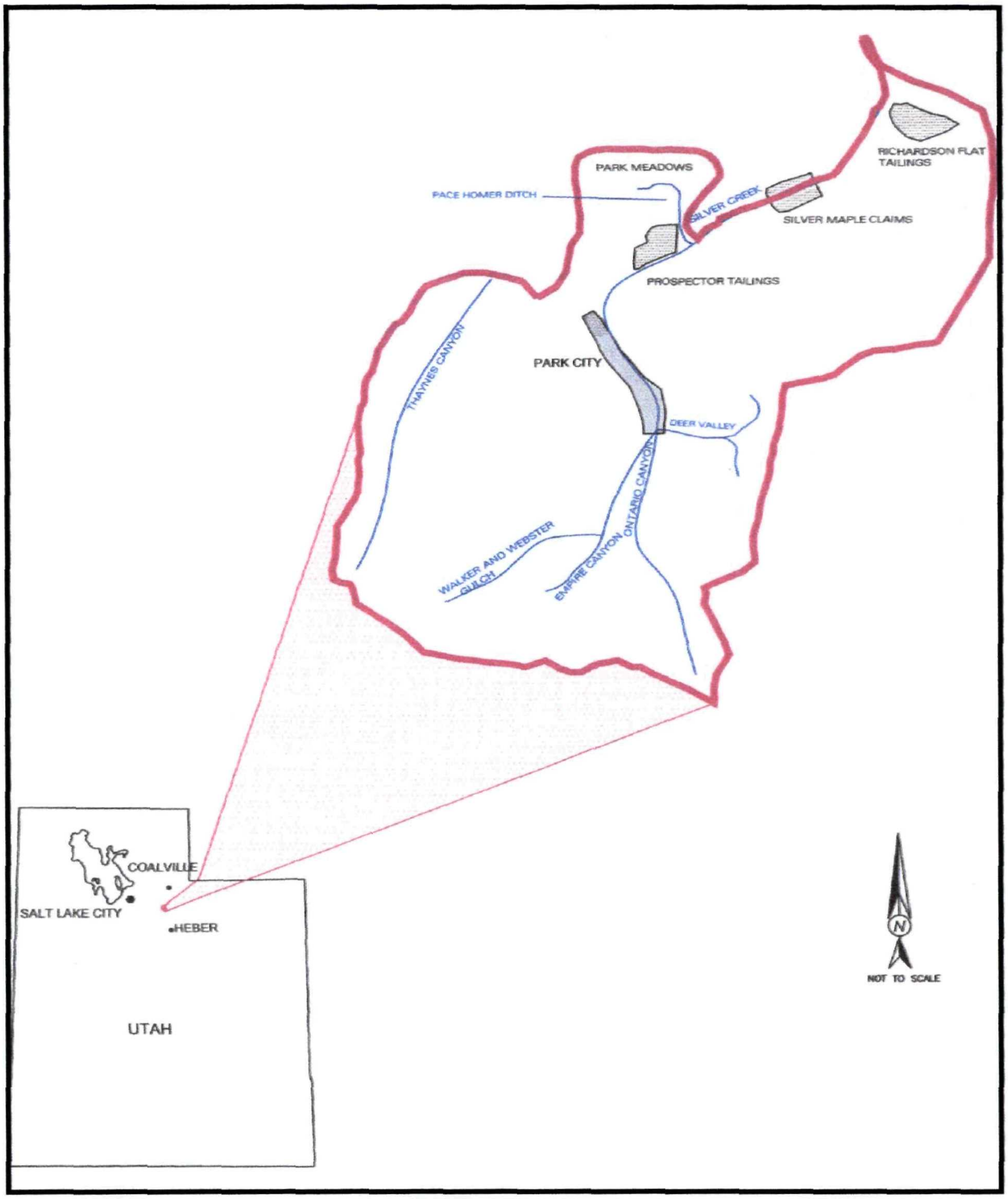


Figure 3-6
Upper Silver Creek Watershed

Screening Ecological Risk Assessment for Richardson Flat Tailings

Source: USEPA, 2001 [Silver Creek Watershed Report]

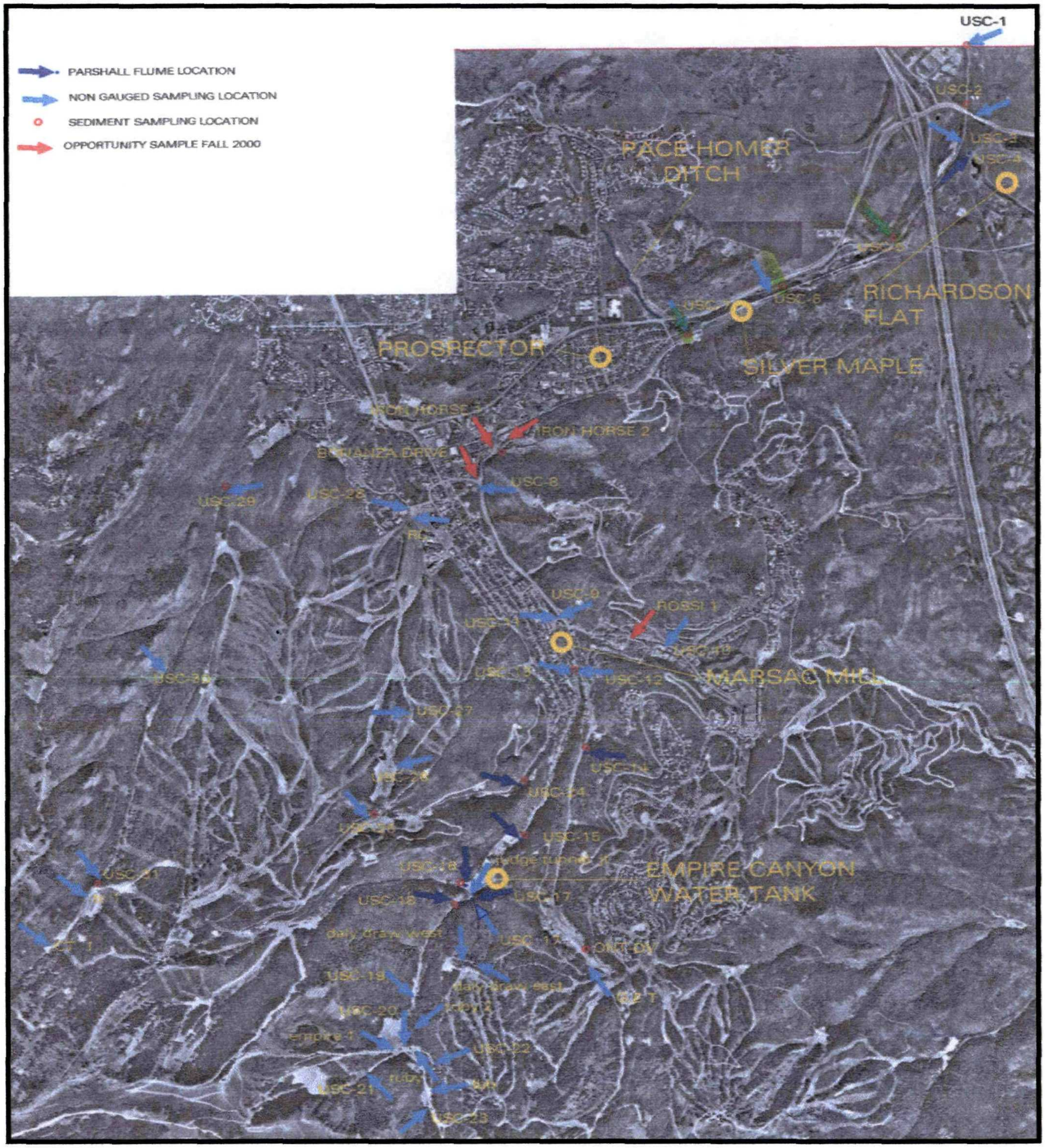


Figure 3-7
USEPA (2001) Upper Silver Creek Watershed
Surface Water and Sediment Sampling Locations

Screening Ecological Risk Assessment for Richardson Flat Tailings

Source: USEPA, 2001 [Silver Creek Watershed Report]

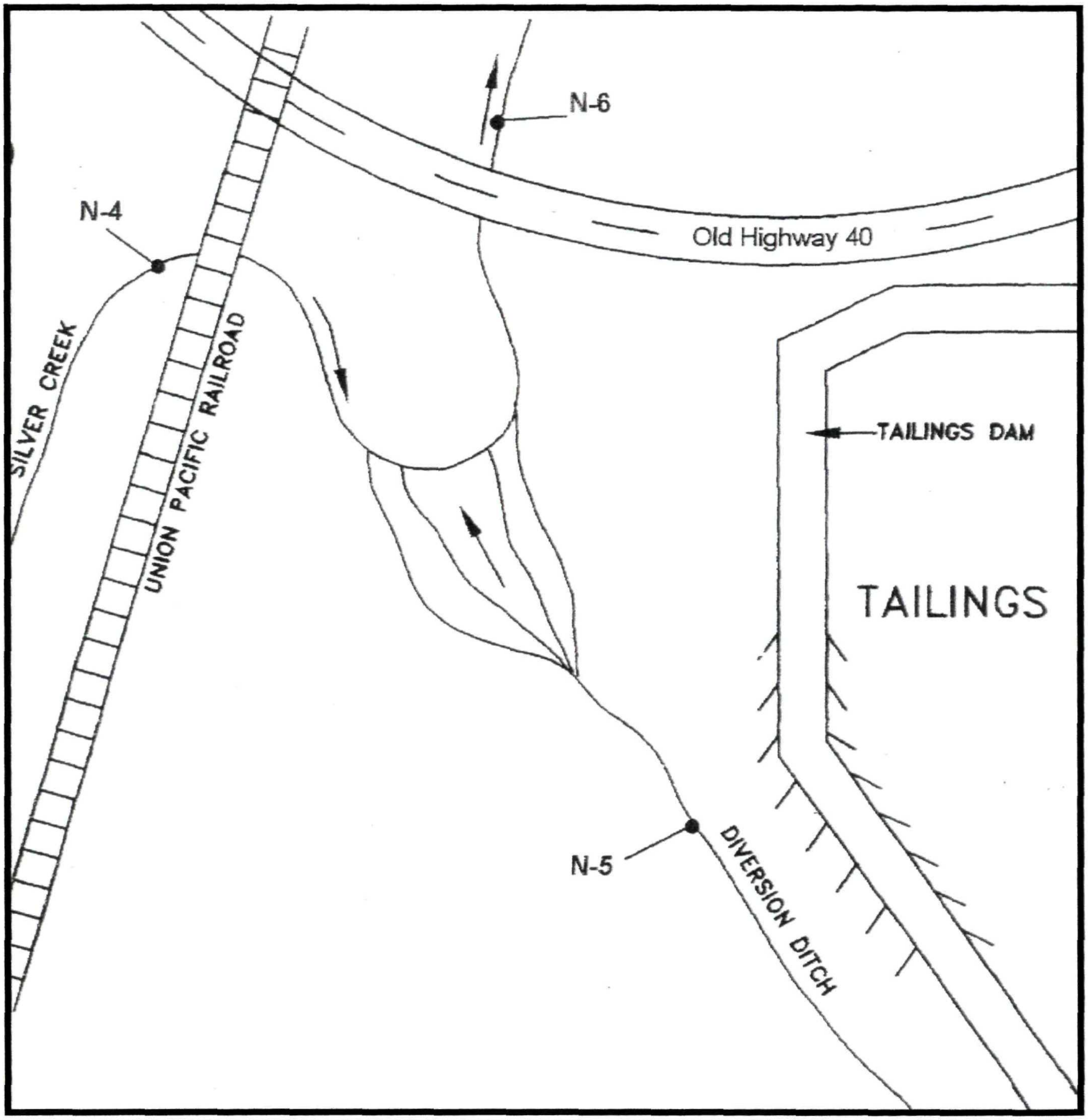


Figure 3-8
UPCM Surface Water Monitoring Locations

Screening Ecological Risk Assessment for Richardson Flat Tailings

Source: RMC, 2001a [RI/FS Workplan]

DRAFT

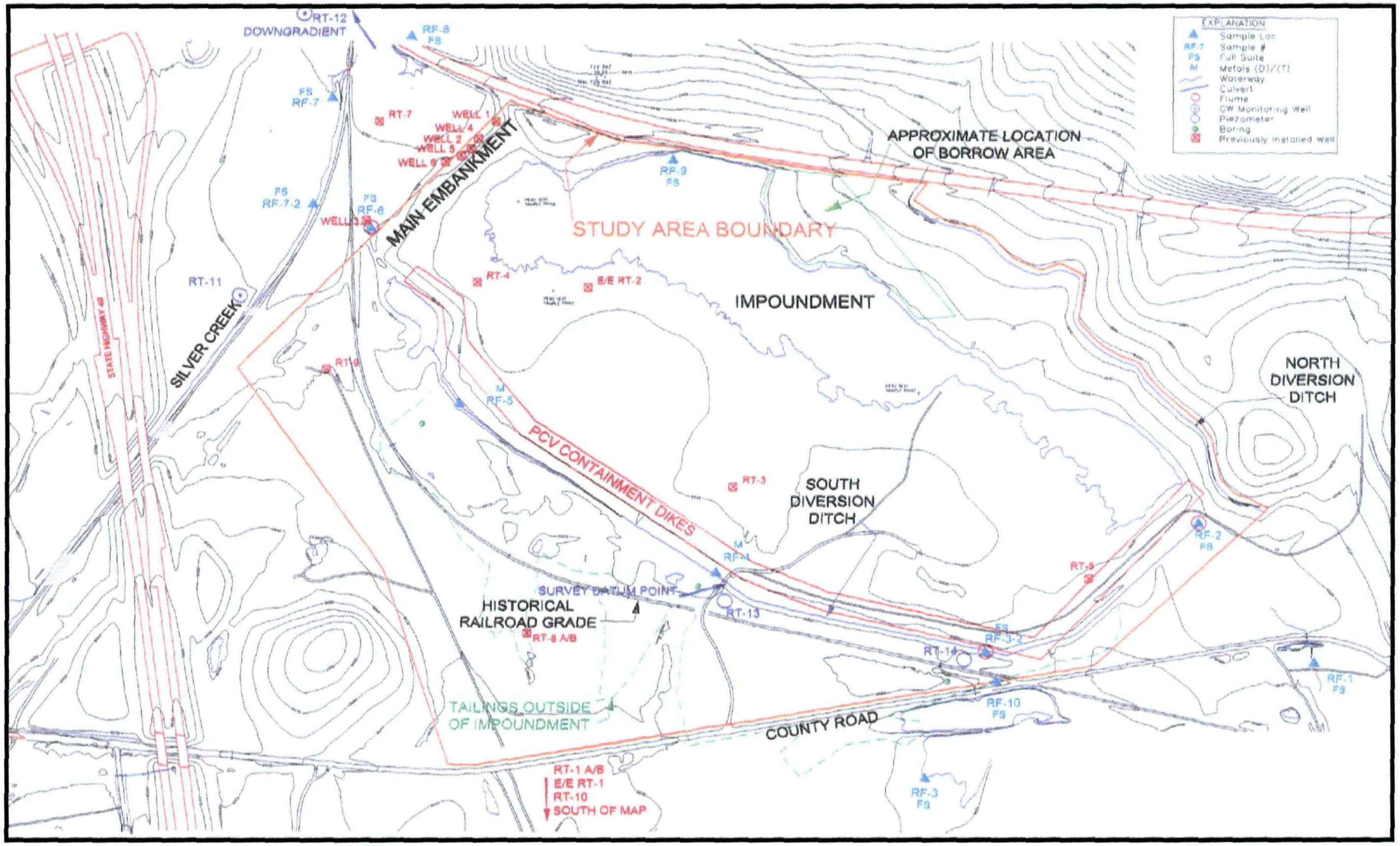


Figure 3-9
RMC On-Impoundment
Surface Water and Groundwater Sampling Locations

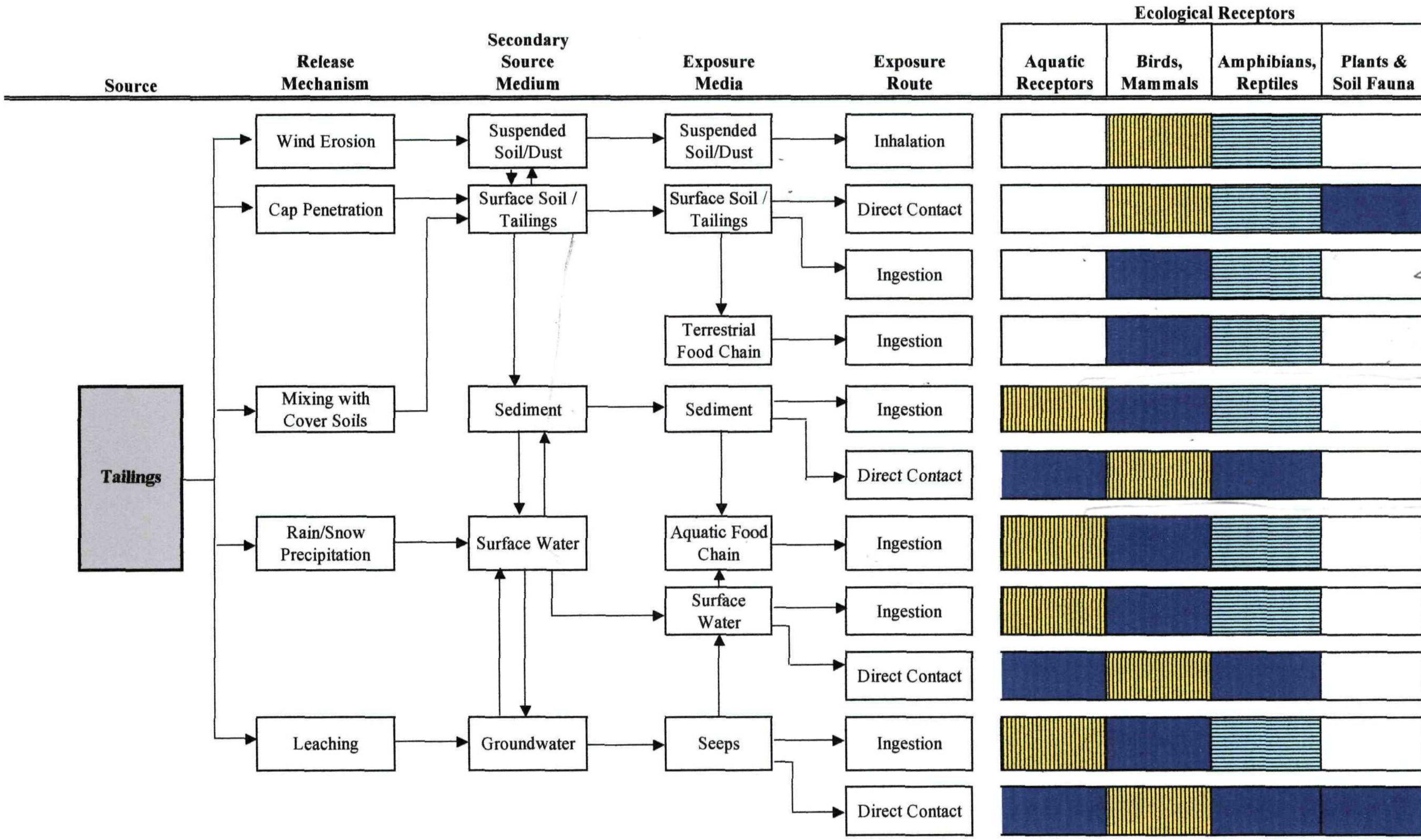
Screening Ecological Risk Assessment for Richardson Flat Tailings

Fig 3-9 RMC OnSite Locations.ppt

Source: Resource Management Consultants, 2000a [RI/FS Workplan]

Figure 4-1
Ecological Site Conceptual Model

Screening Ecological Risk Assessment for the Richardson Flat Tailings



This should be filled

Pathway not complete - no evaluation
Pathway complete, but considered insignificant relative to other pathways of concern - no evaluation
Pathway complete, but either exposure or toxicity data are not available and risk evaluation impossible - no evaluation
Pathway complete and selected for quantitative evaluation

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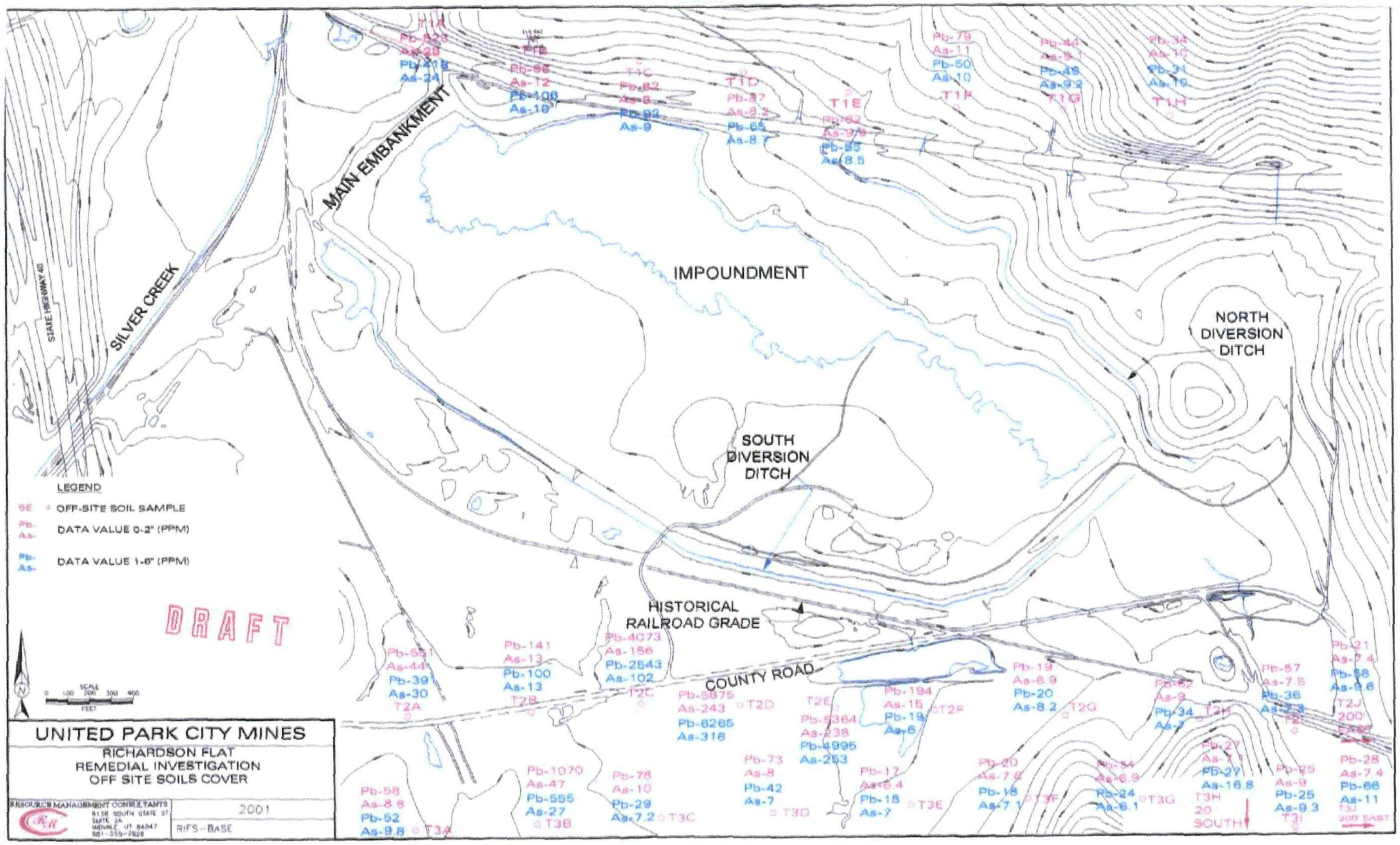


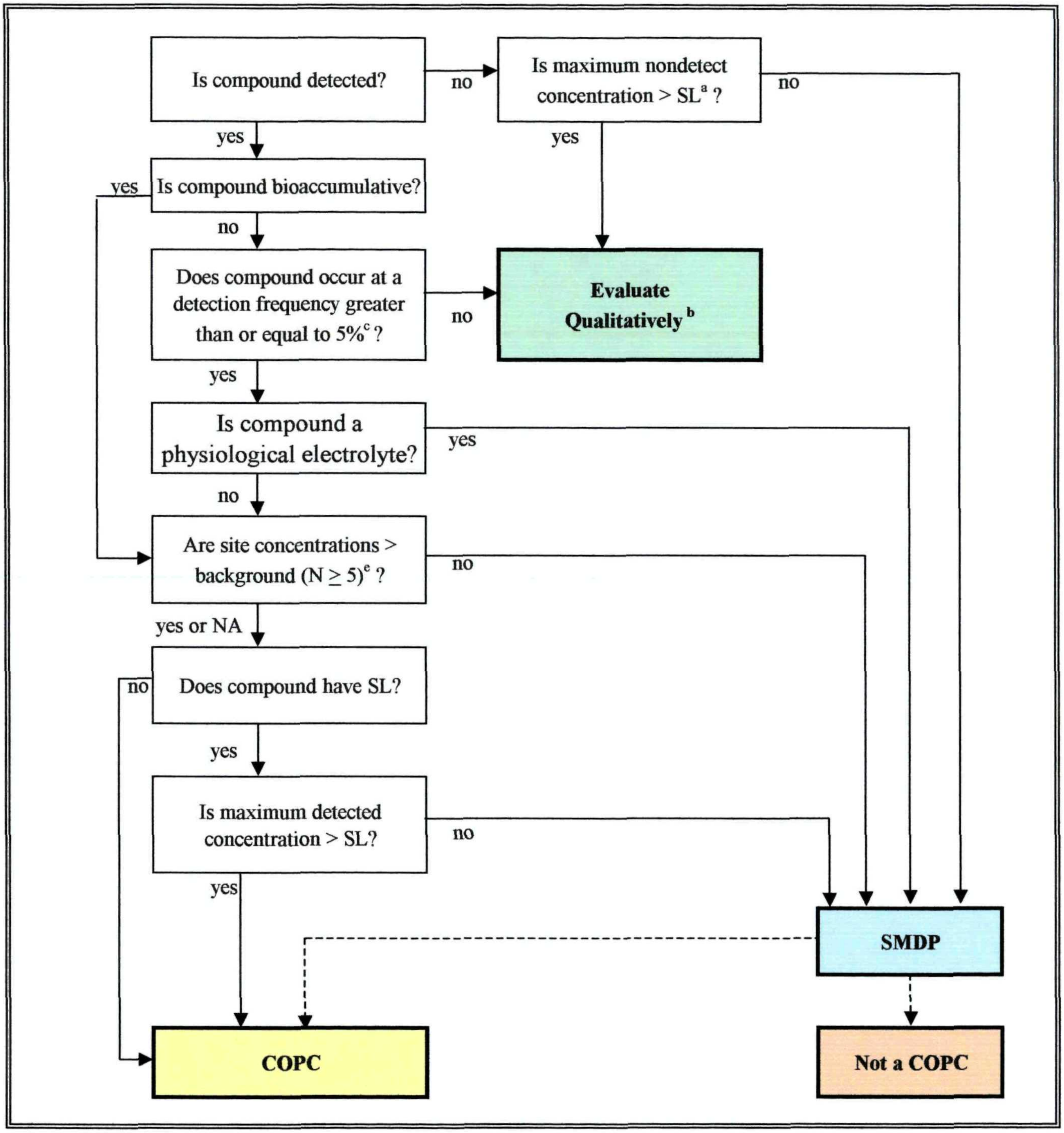
Figure 4-2
Off-Impoundment Cover Soils Map

Screening Ecological Risk Assessment for Richardson Flat Tailings

Source: Resource Management Consultants, 2001 (DRAFT RI/FS)

Figure 4-3
Ecological Screening Methodology for COPC Selection

Screening Ecological Risk Assessment for Richardson Flat Tailings



Notes:

SL = screening level

NA = not available

COPC = chemical of potential concern

SMDP = scientific management decision point

a If ecological SL is not available, the adequacy of detection limits will be evaluated qualitatively in the screening ERA as part of the uncertainty analyses.

b Chemical is not identified as a COPC, but chemical is a source of uncertainty.

c Detection frequency screening step also identifies if chemical is plausibly site-related.

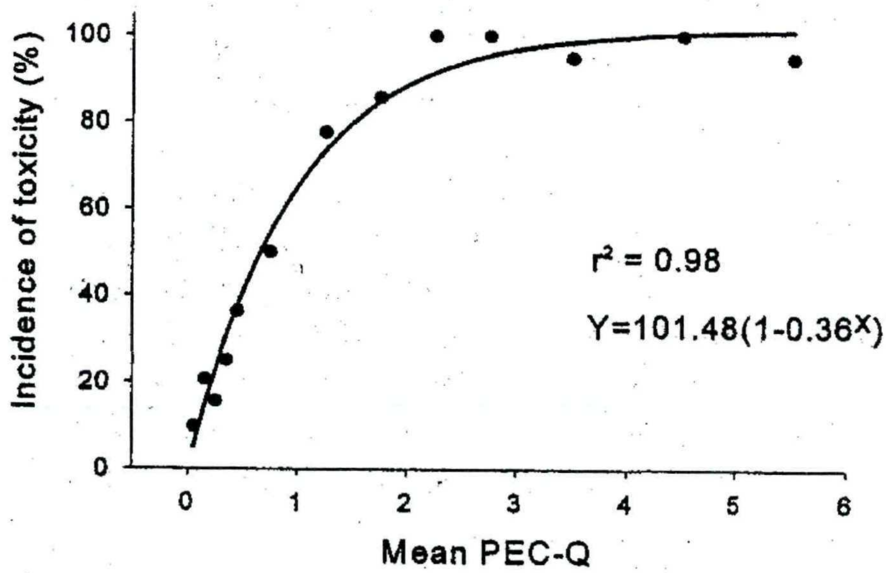
d Physiological Electrolytes include calcium, iron, magnesium, sodium, and potassium.

e Background comparisons are described in the text.

COPC Selection Flowchart.xls: eco_COCselection, 2/14/2002

Figure 6-1
Relationship Between Mean PEC Quotient and Incidence of Toxicity in Freshwater Sediments

Screening Ecological Risk Assessment for the Richardson Flat Tailings Site

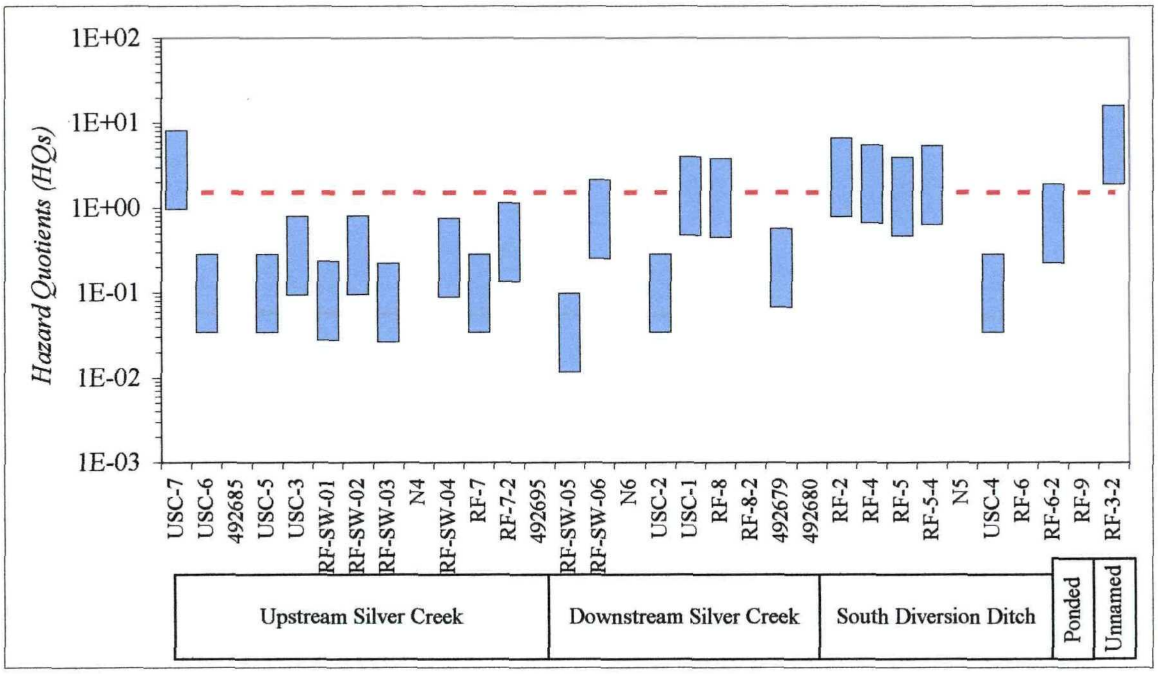


Source: MacDonald et al., 2000 - Figure 1

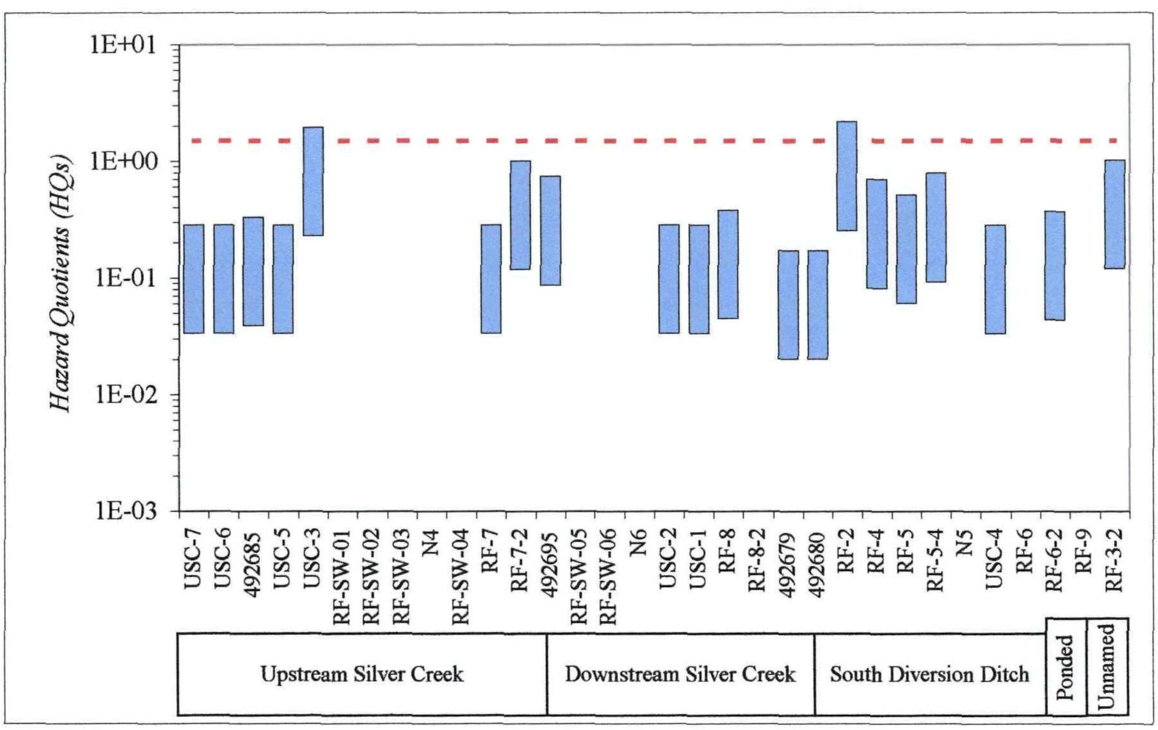
Figure 7-1
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Surface Water

Screening Ecological Risk Assessment for Richardson Flats Tailings

TOTAL ALUMINUM



DISSOLVED ALUMINUM

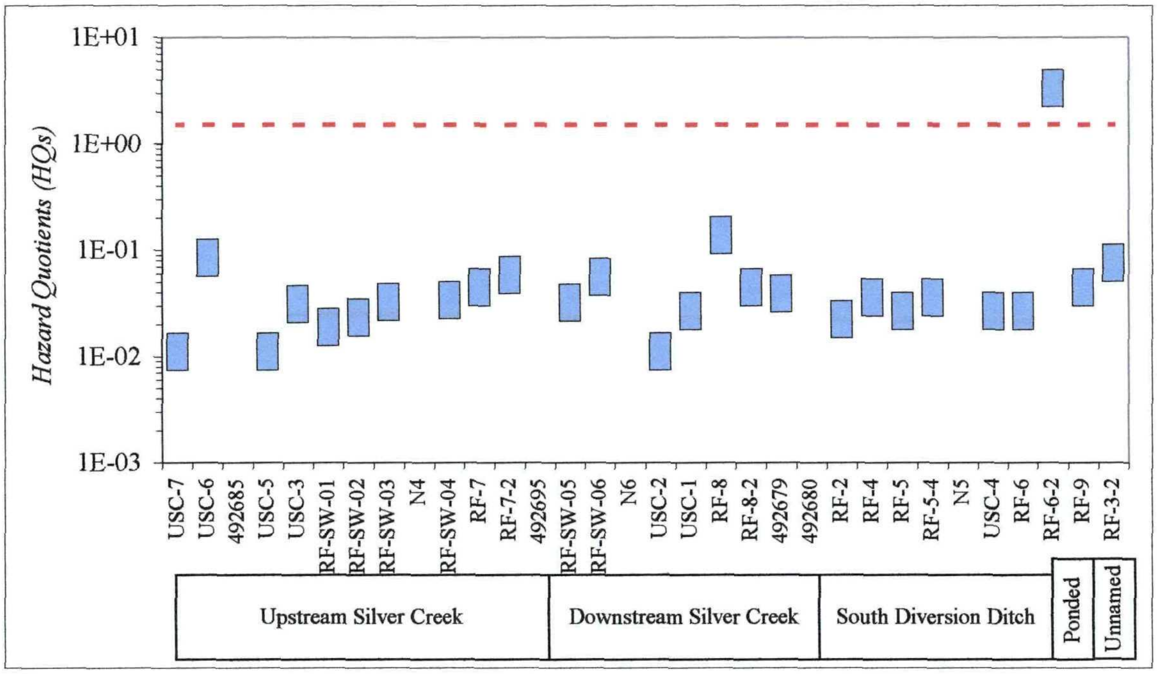


HQ ranges are based on the acute and chronic AWQC.

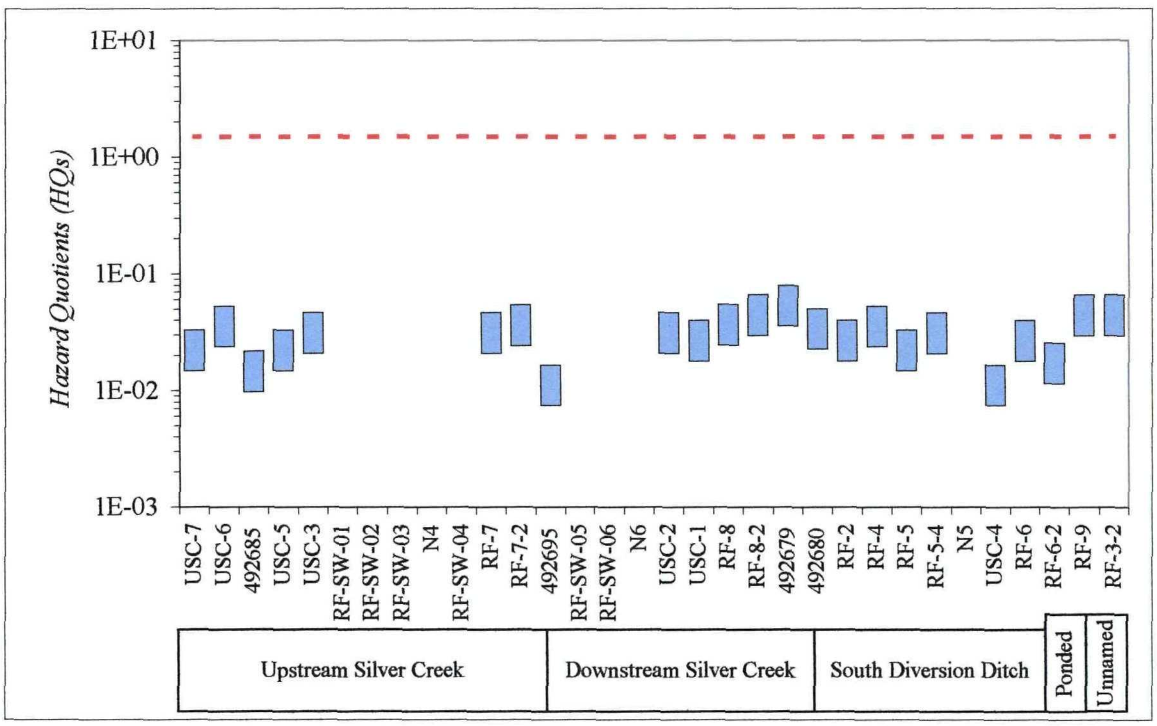
Figure 7-1
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Surface Water

Screening Ecological Risk Assessment for Richardson Flats Tailings

TOTAL ARSENIC



DISSOLVED ARSENIC

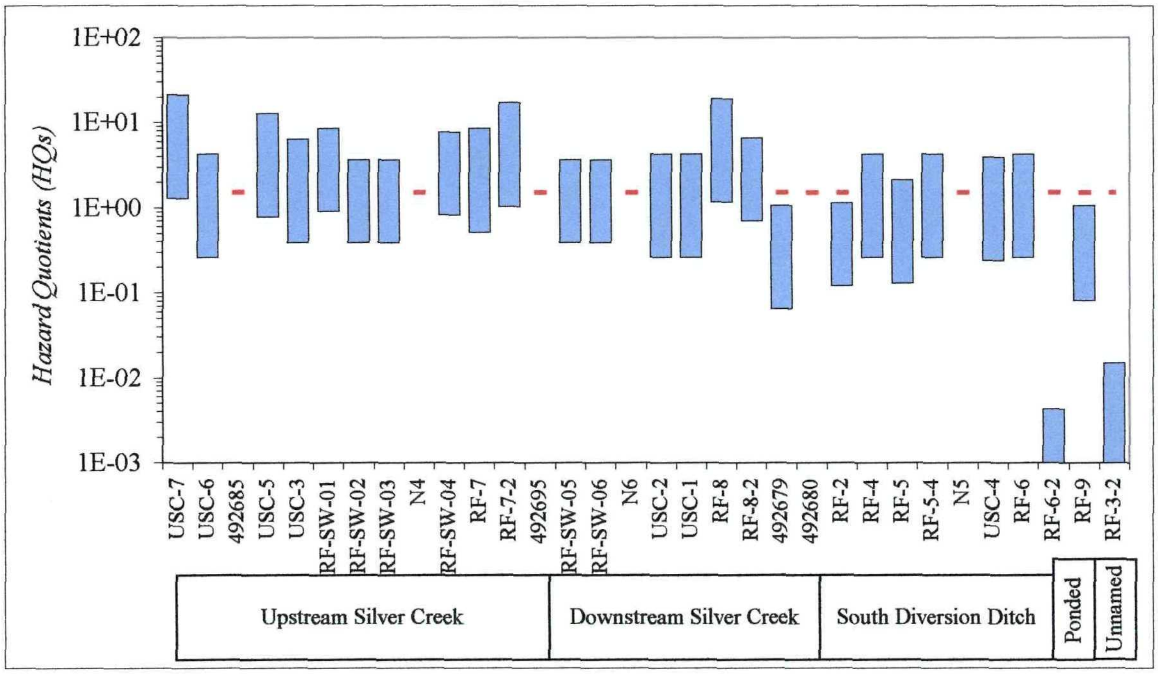


HQ ranges are based on the acute and chronic AWQC.

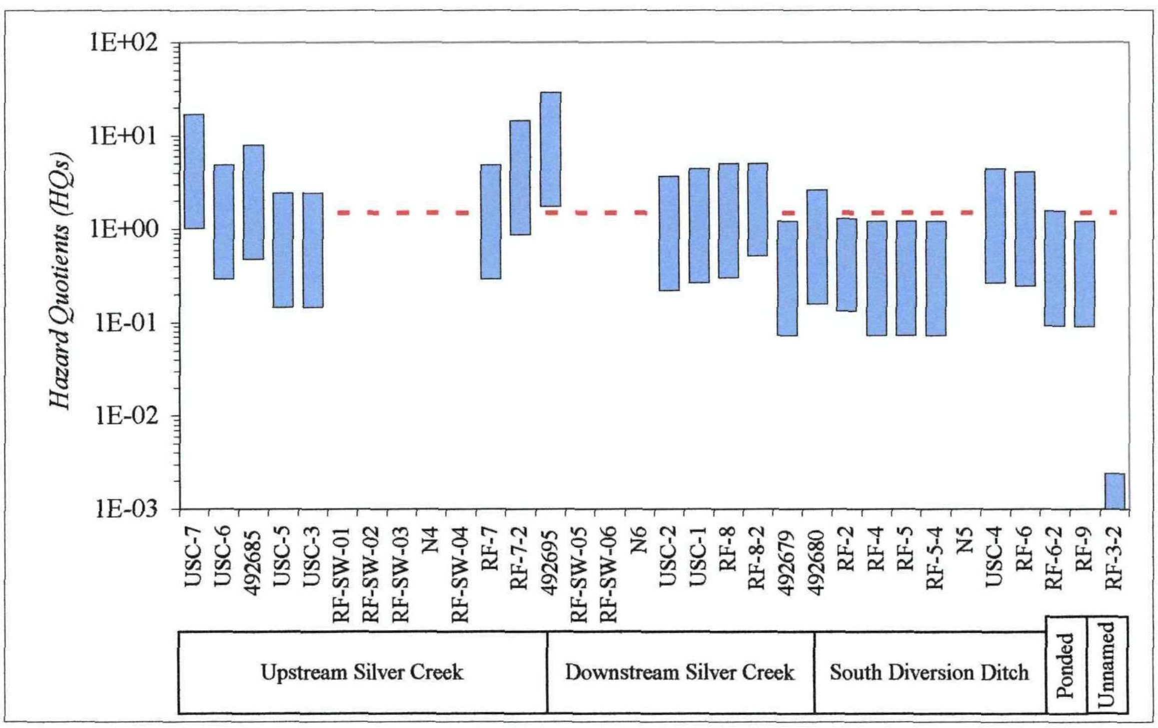
Figure 7-1
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Surface Water

Screening Ecological Risk Assessment for Richardson Flats Tailings

TOTAL CADMIUM



DISSOLVED CADMIUM

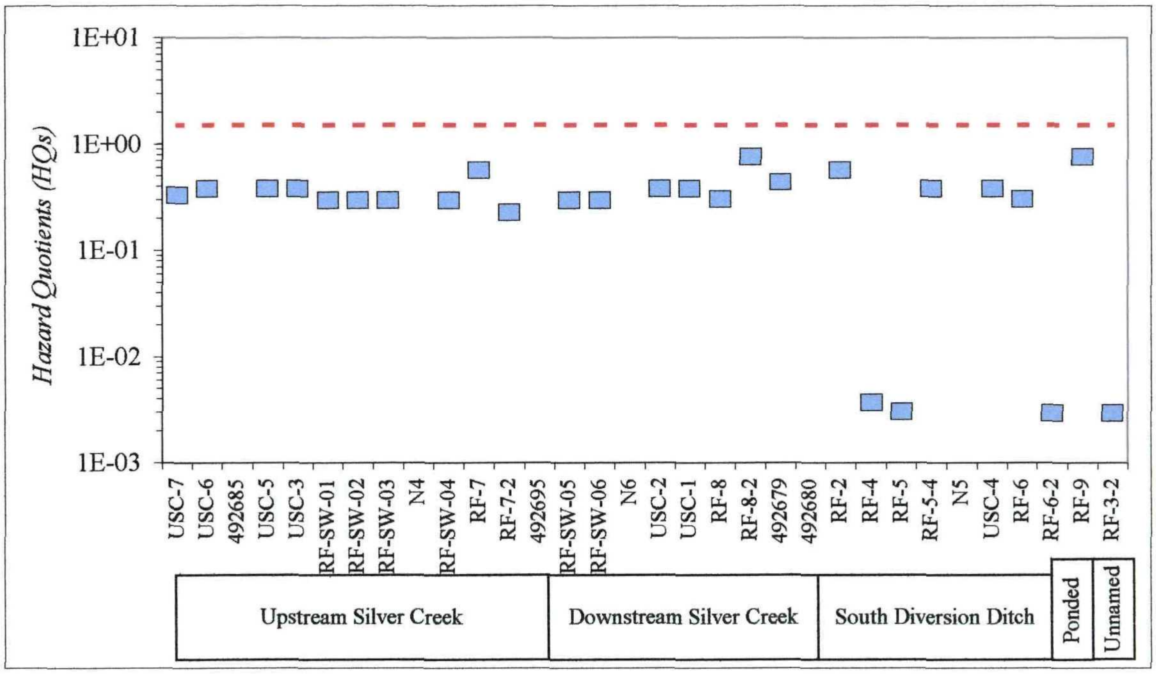


HQ ranges are based on the acute and chronic AWQC.

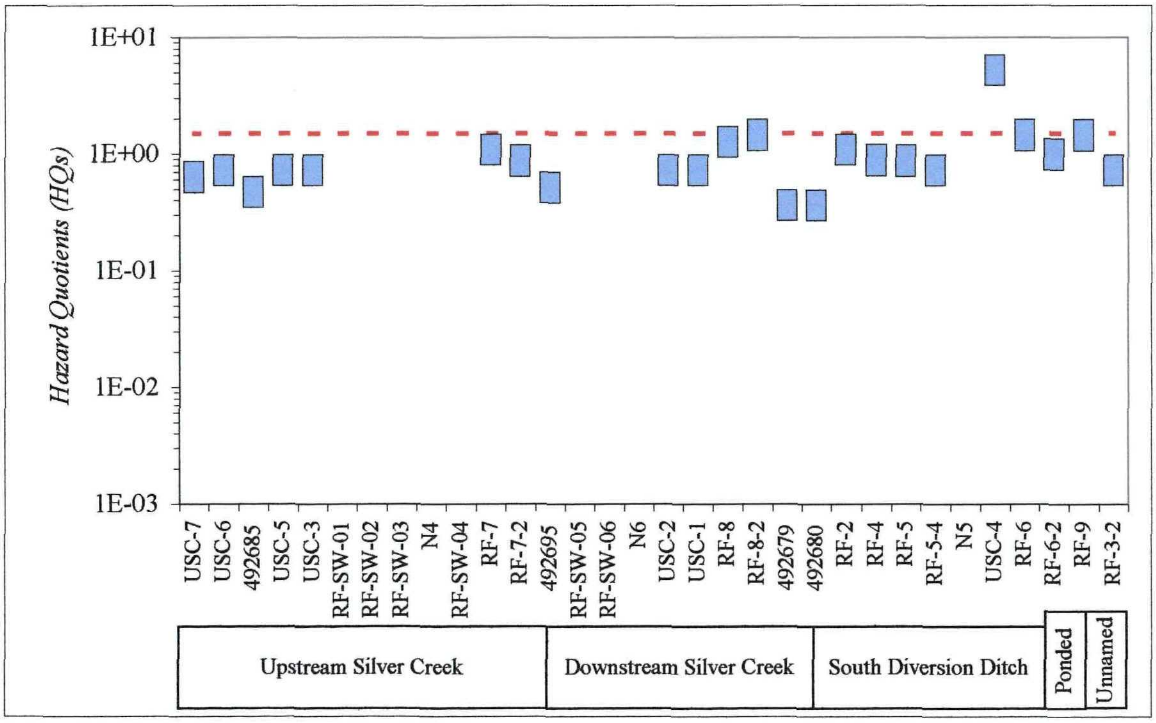
Figure 7-1
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Surface Water

Screening Ecological Risk Assessment for Richardson Flats Tailings

TOTAL CHROMIUM



DISSOLVED CHROMIUM



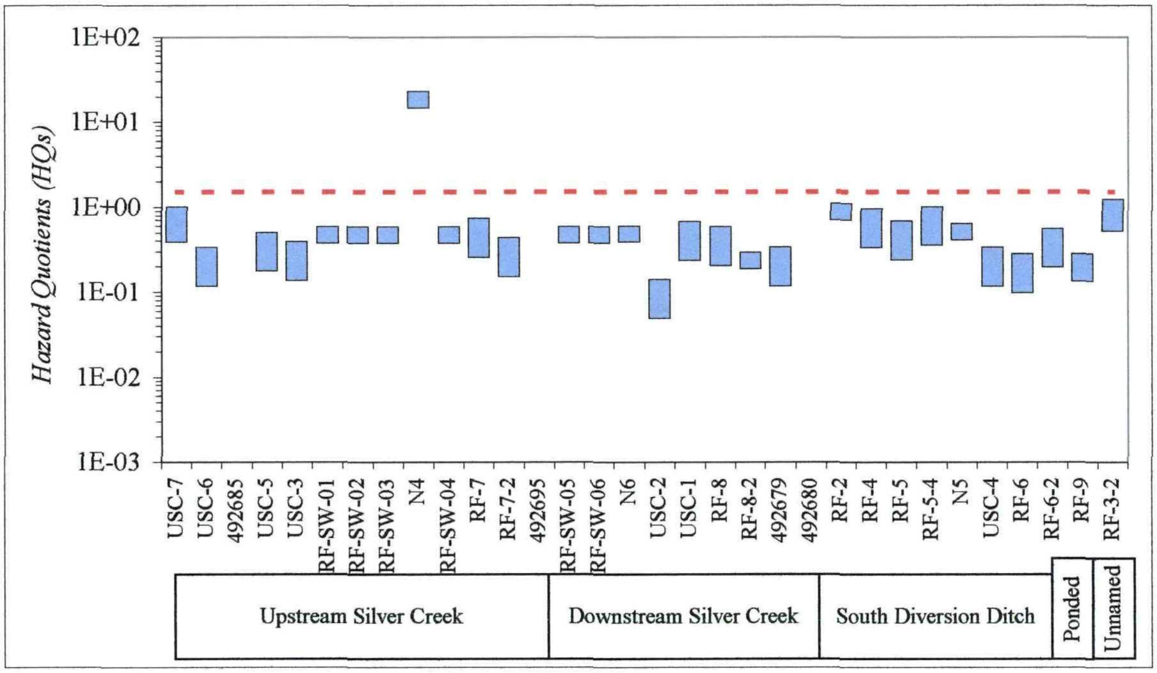
HQ ranges are based on the acute and chronic AWQC.

Figure 7-1

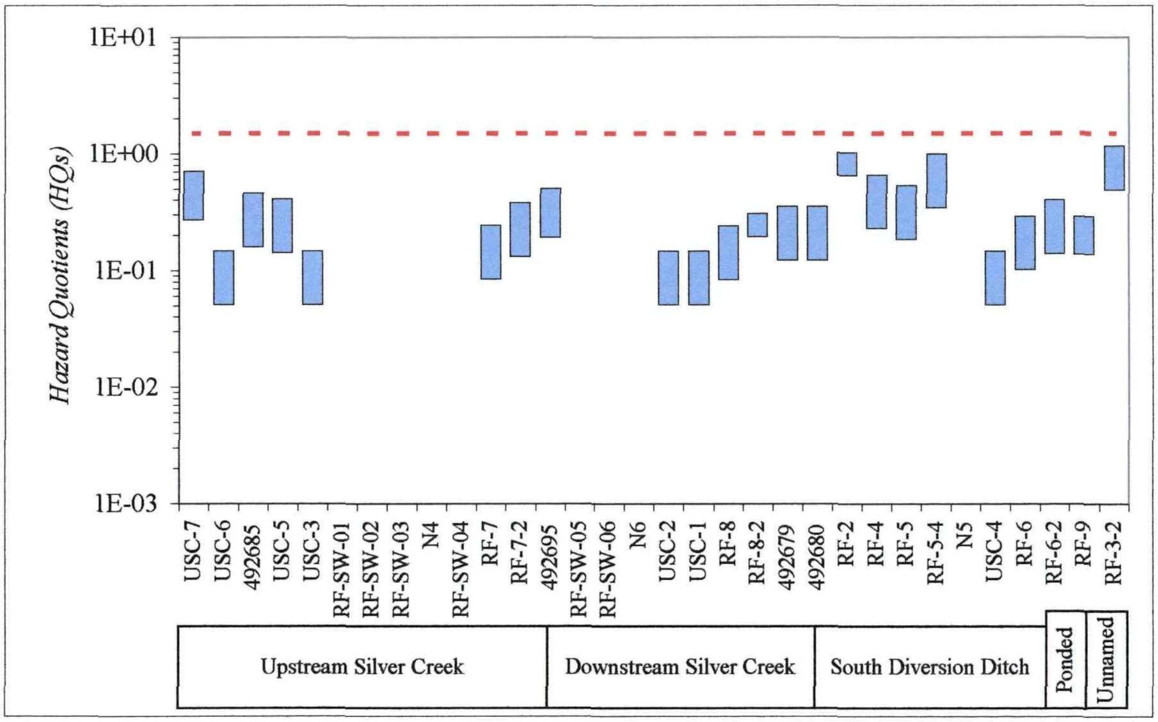
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Surface Water

Screening Ecological Risk Assessment for Richardson Flats Tailings

TOTAL COPPER



DISSOLVED COPPER

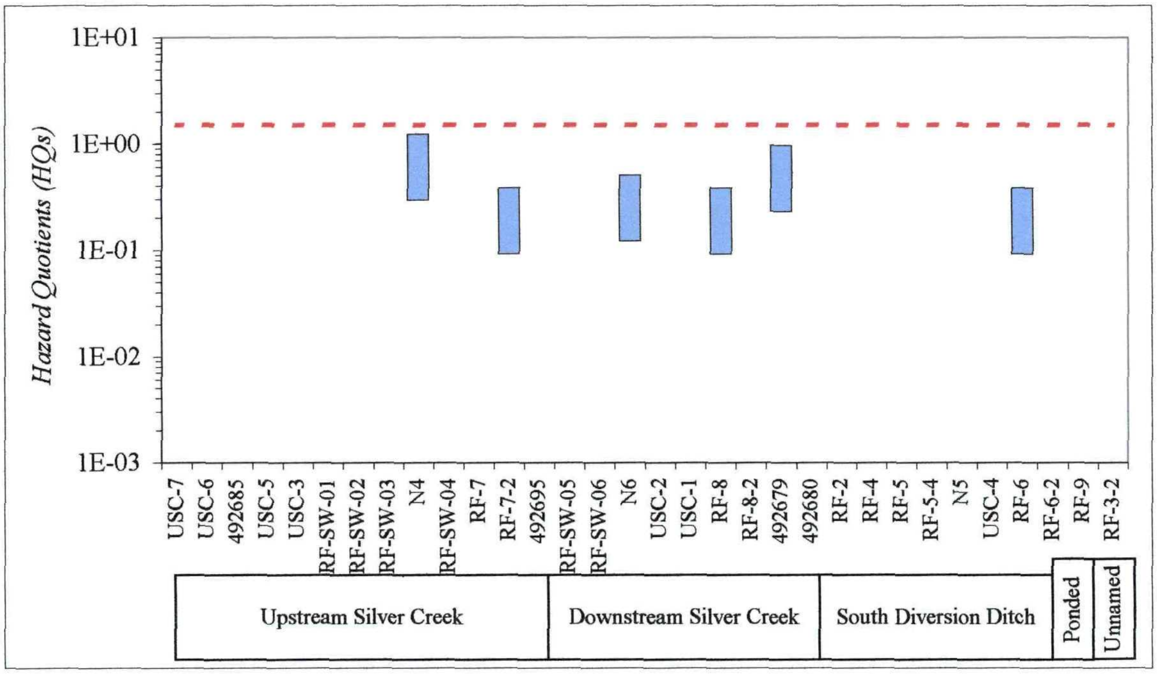


HQ ranges are based on the acute and chronic AWQC.

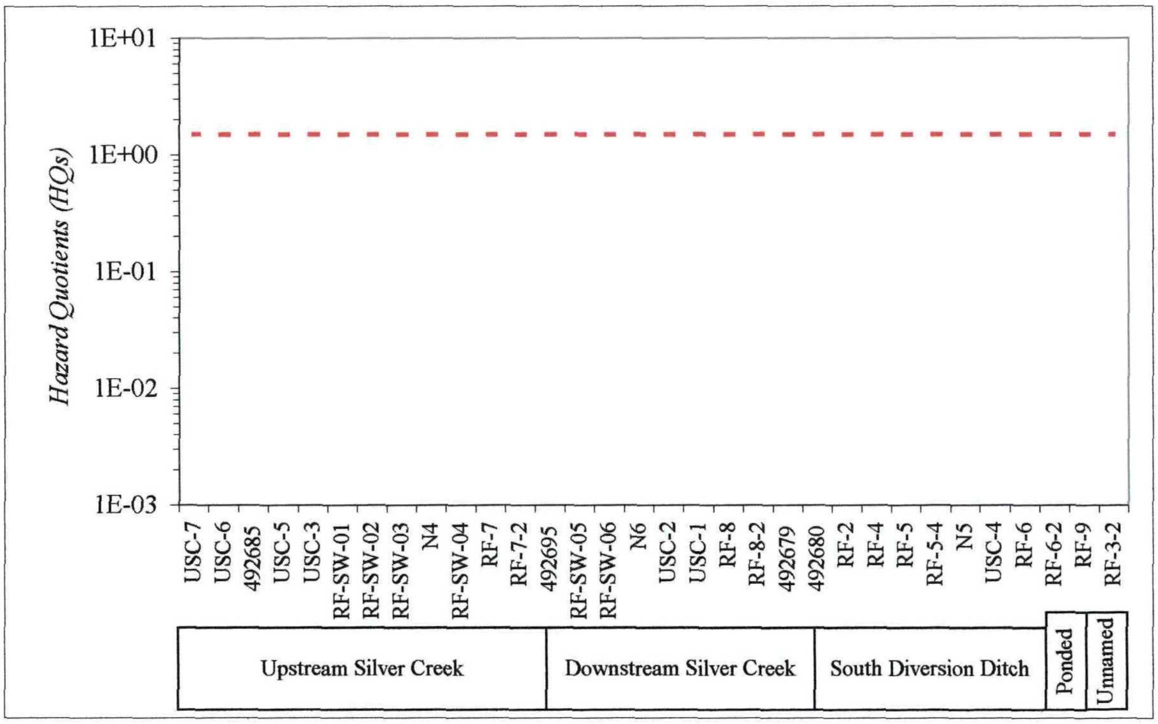
Figure 7-1
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Surface Water

Screening Ecological Risk Assessment for Richardson Flats Tailings

TOTAL CYANIDE



DISSOLVED CYANIDE

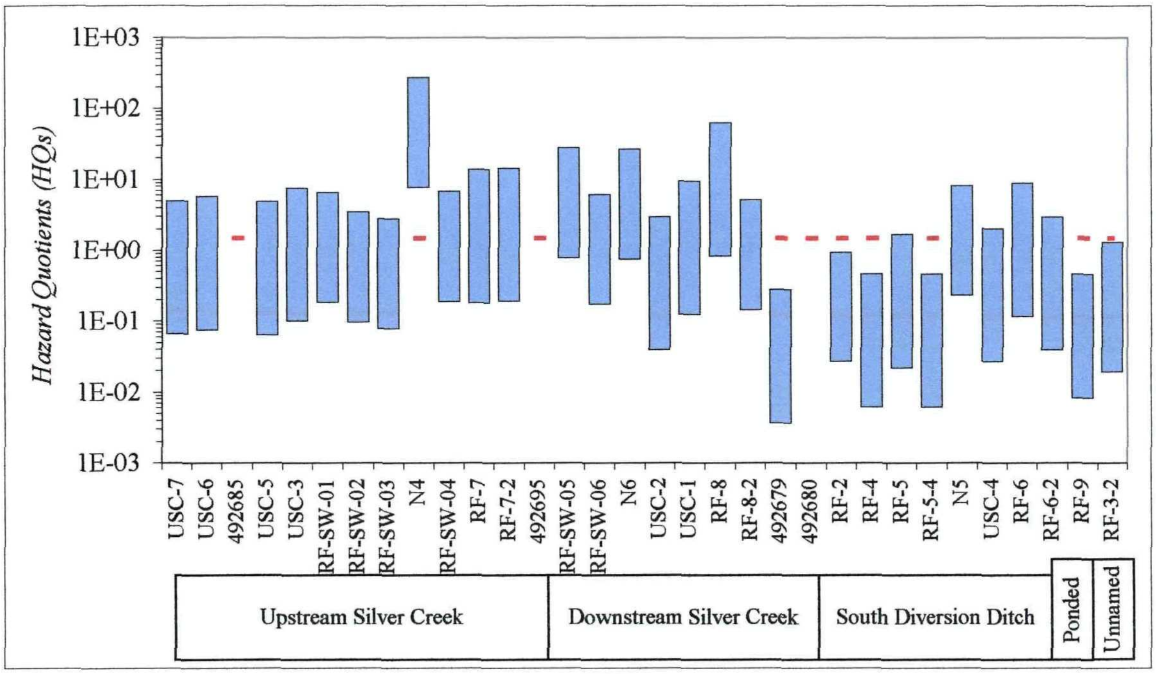


HQ ranges are based on the acute and chronic AWQC.

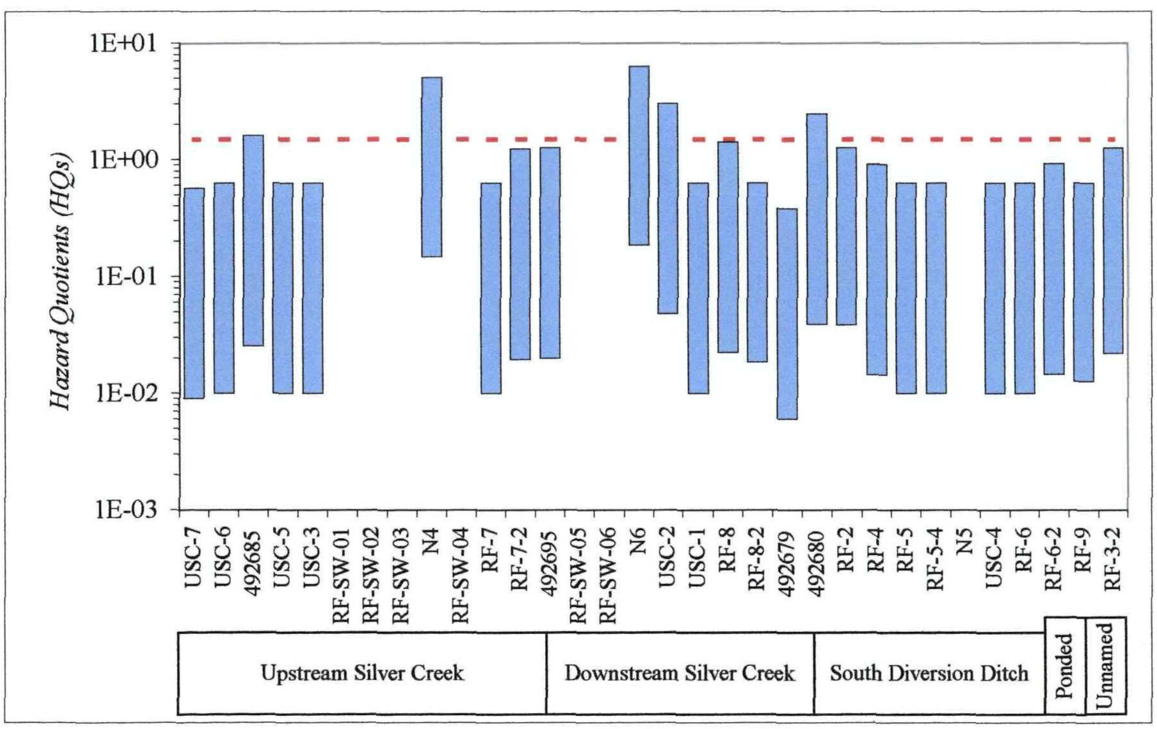
Figure 7-1
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Surface Water

Screening Ecological Risk Assessment for Richardson Flats Tailings

TOTAL LEAD



DISSOLVED LEAD

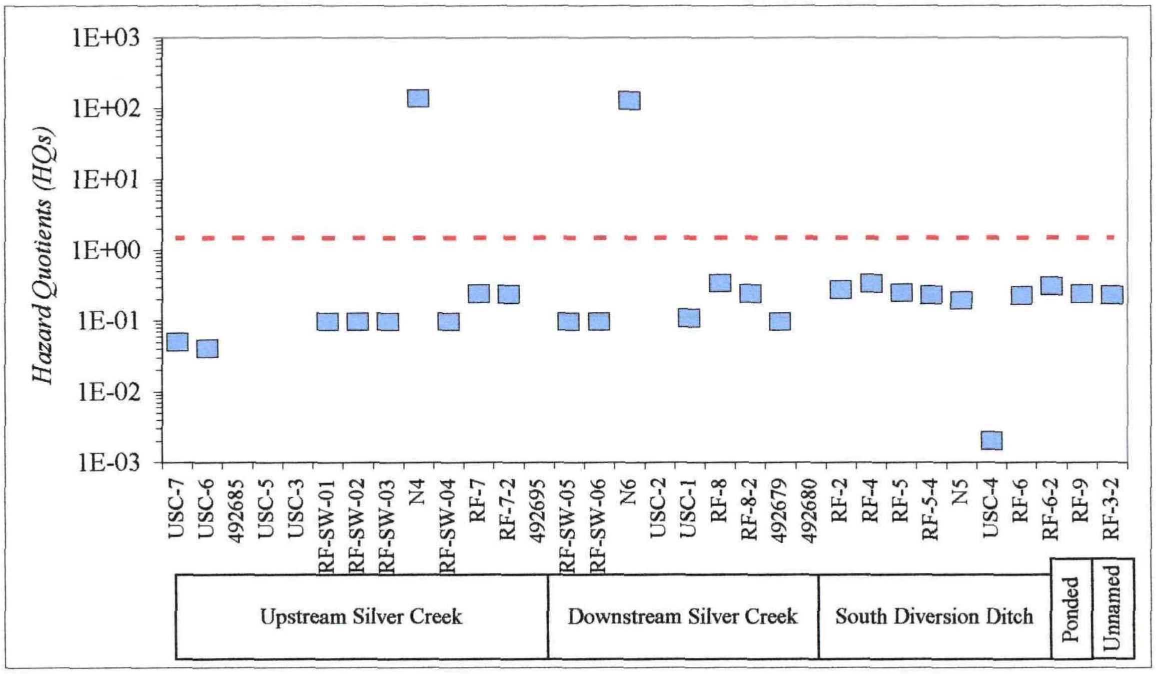


HQ ranges are based on the acute and chronic AWQC.

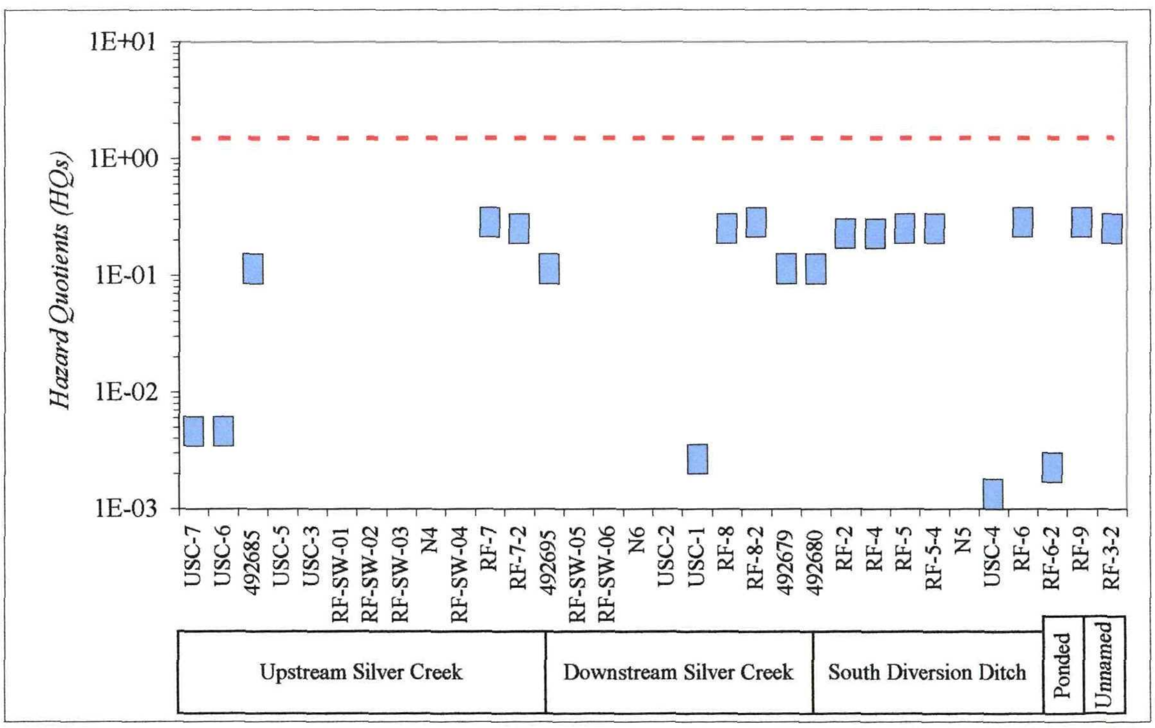
Figure 7-1
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Surface Water

Screening Ecological Risk Assessment for Richardson Flats Tailings

TOTAL MERCURY



DISSOLVED MERCURY



HQ ranges are based on the acute and chronic AWQC.

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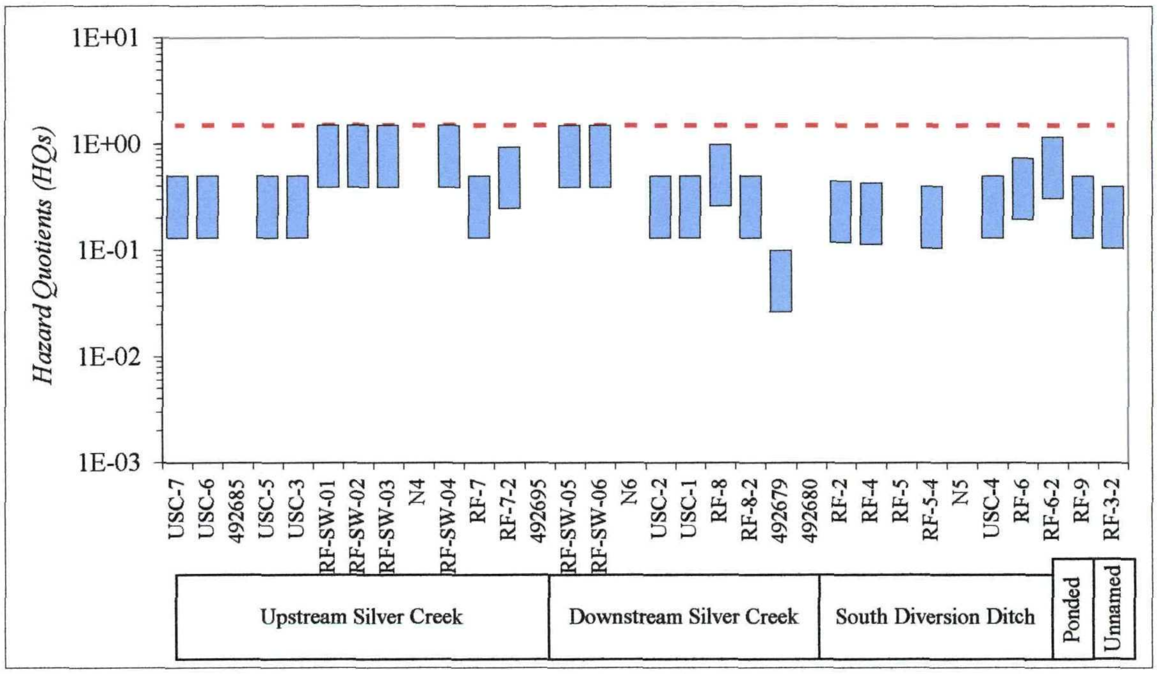
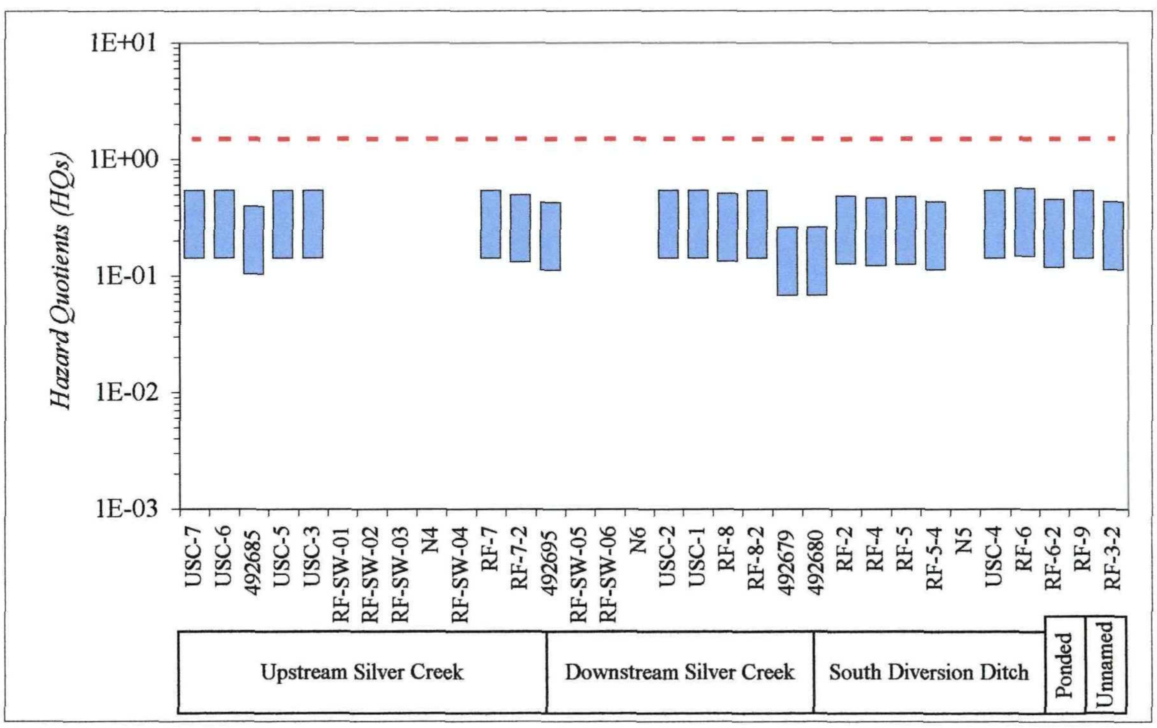
Figure 7-1
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Surface Water

Screening Ecological Risk Assessment for Richardson Flats Tailings

TOTAL SELENIUM



DISSOLVED SELENIUM

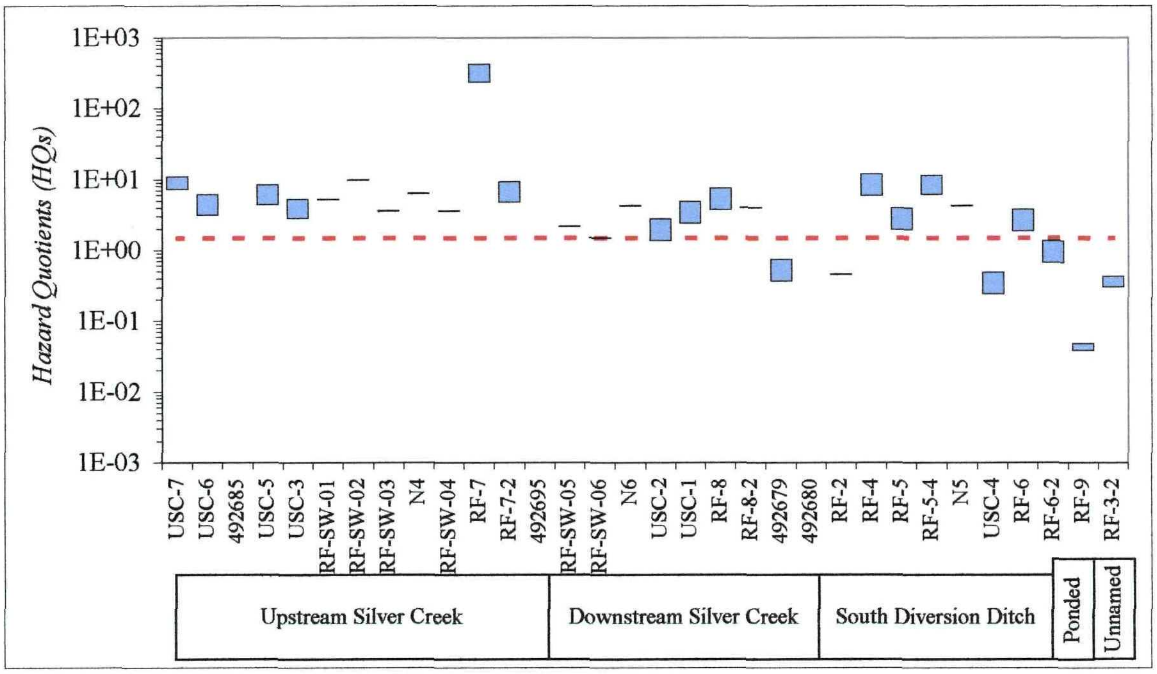


HQ ranges are based on the acute and chronic AWQC.

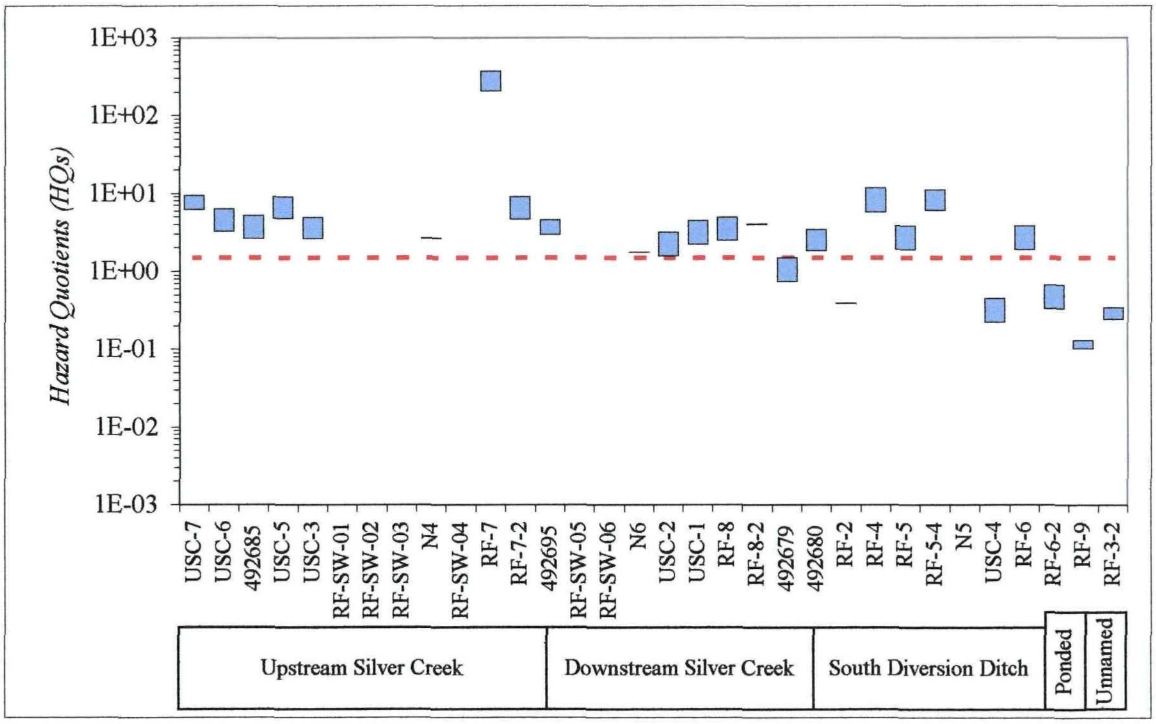
Figure 7-1
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Surface Water

Screening Ecological Risk Assessment for Richardson Flats Tailings

TOTAL ZINC



DISSOLVED ZINC

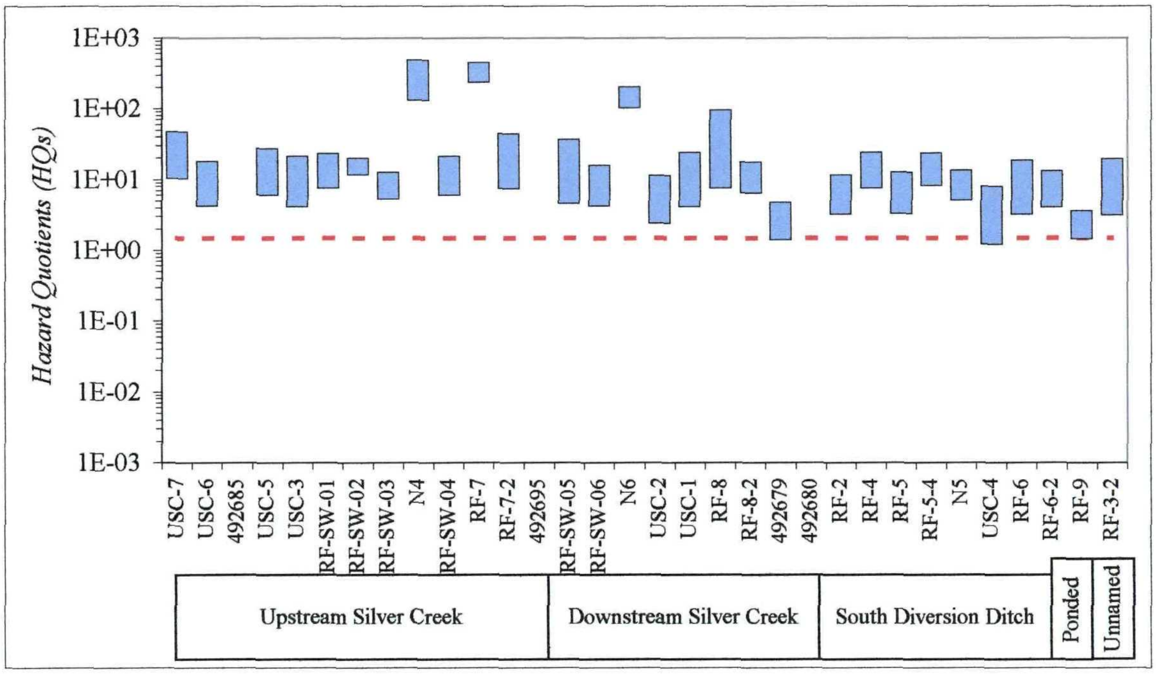


HQ ranges are based on the acute and chronic AWQC.

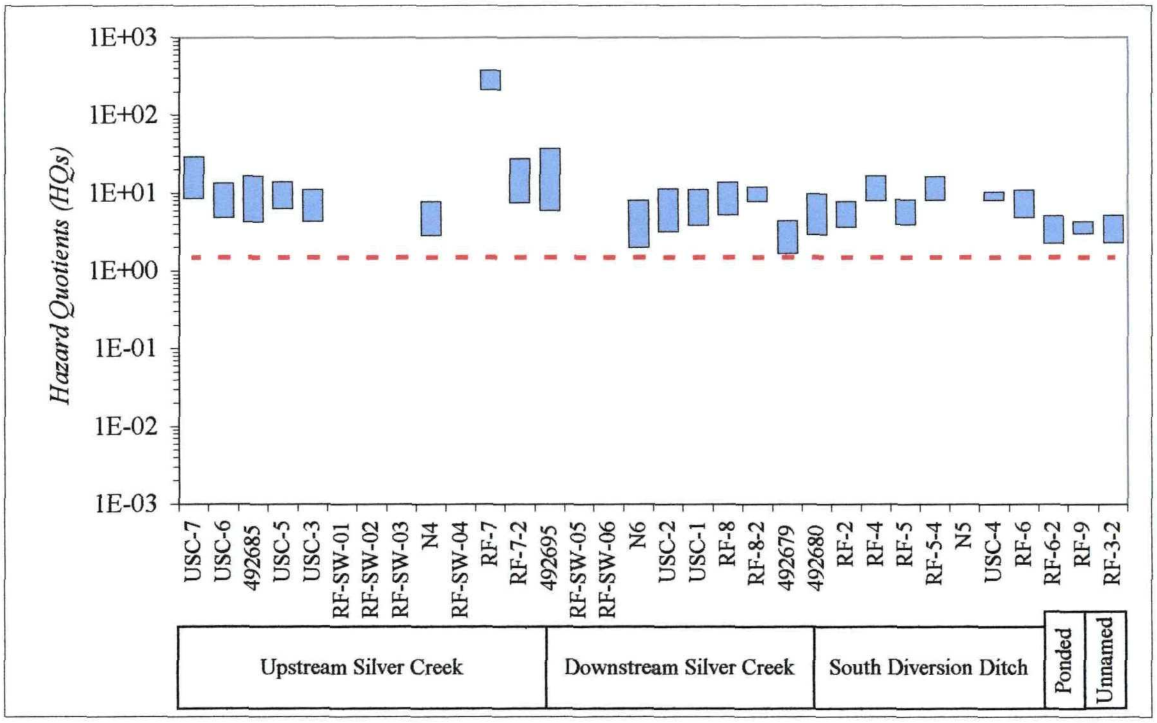
Figure 7-1
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Surface Water

Screening Ecological Risk Assessment for Richardson Flats Tailings

TOTAL TOTAL HI



DISSOLVED TOTAL HI

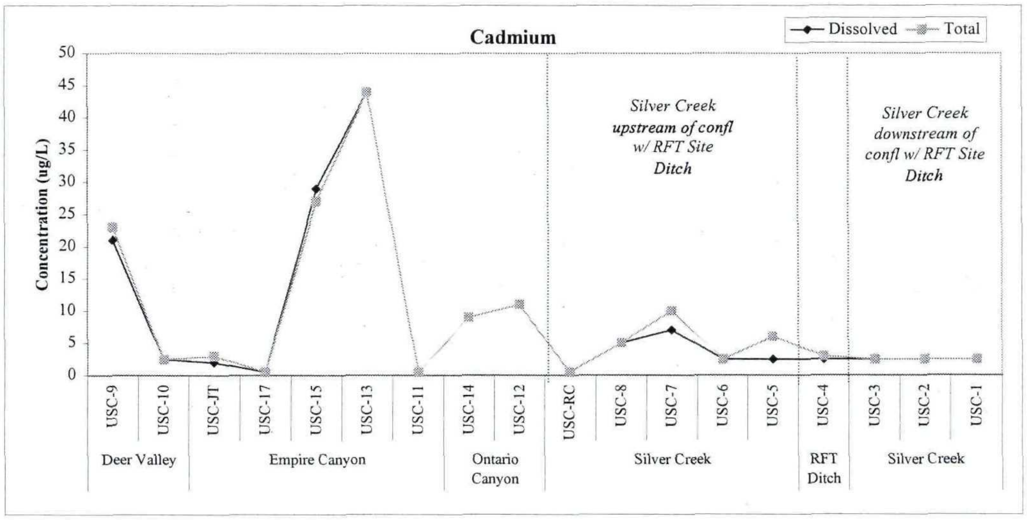


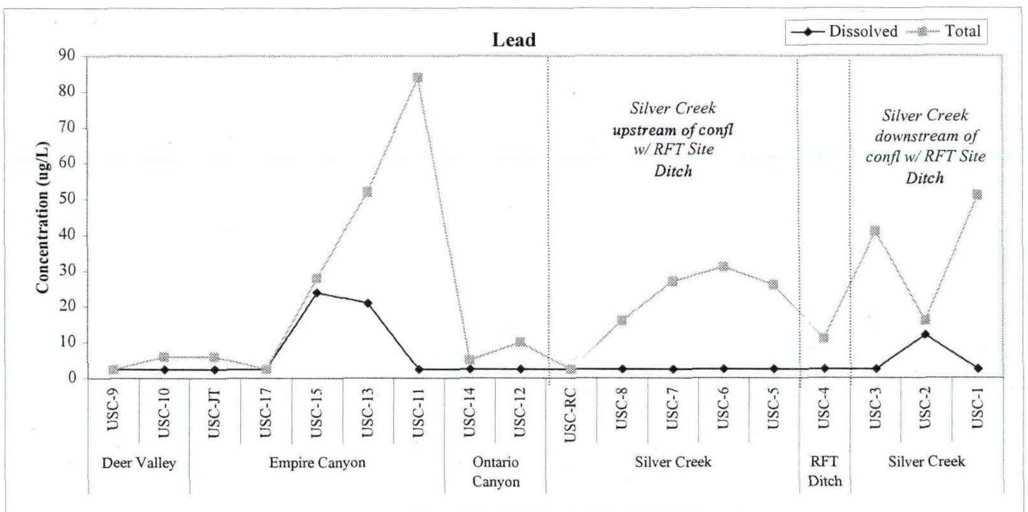
HQ ranges are based on the acute and chronic AWQC.

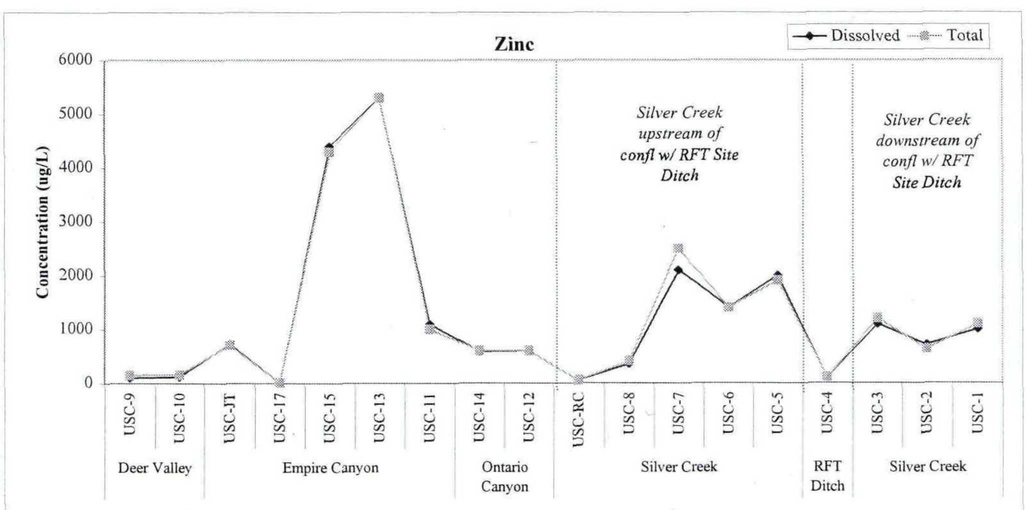
DRAFT

Figure 7-2
Concentrations of Cadmium, Lead and Zinc in the Upper Silver Creek Watershed

Screening Ecological Risk Assessment for Richardson Flat Tailings





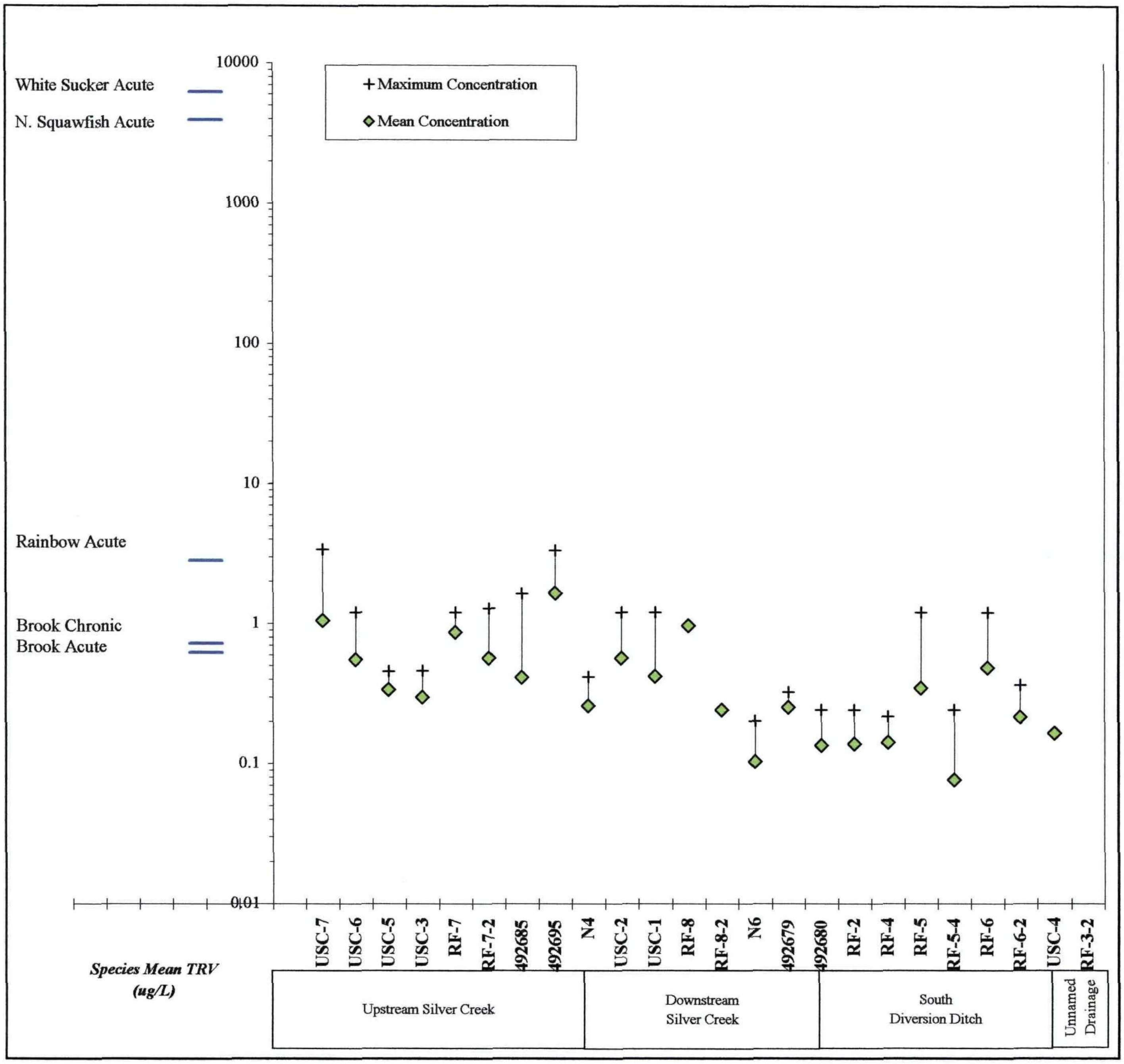


Source: USEPA, 2001

Figure 7-3a

Comparison of Dissolved Cadmium Concentrations with Species Mean Acute and Chronic Values for Fish

Screening Level Ecological Risk Assessment for Richardson Flat Tailings



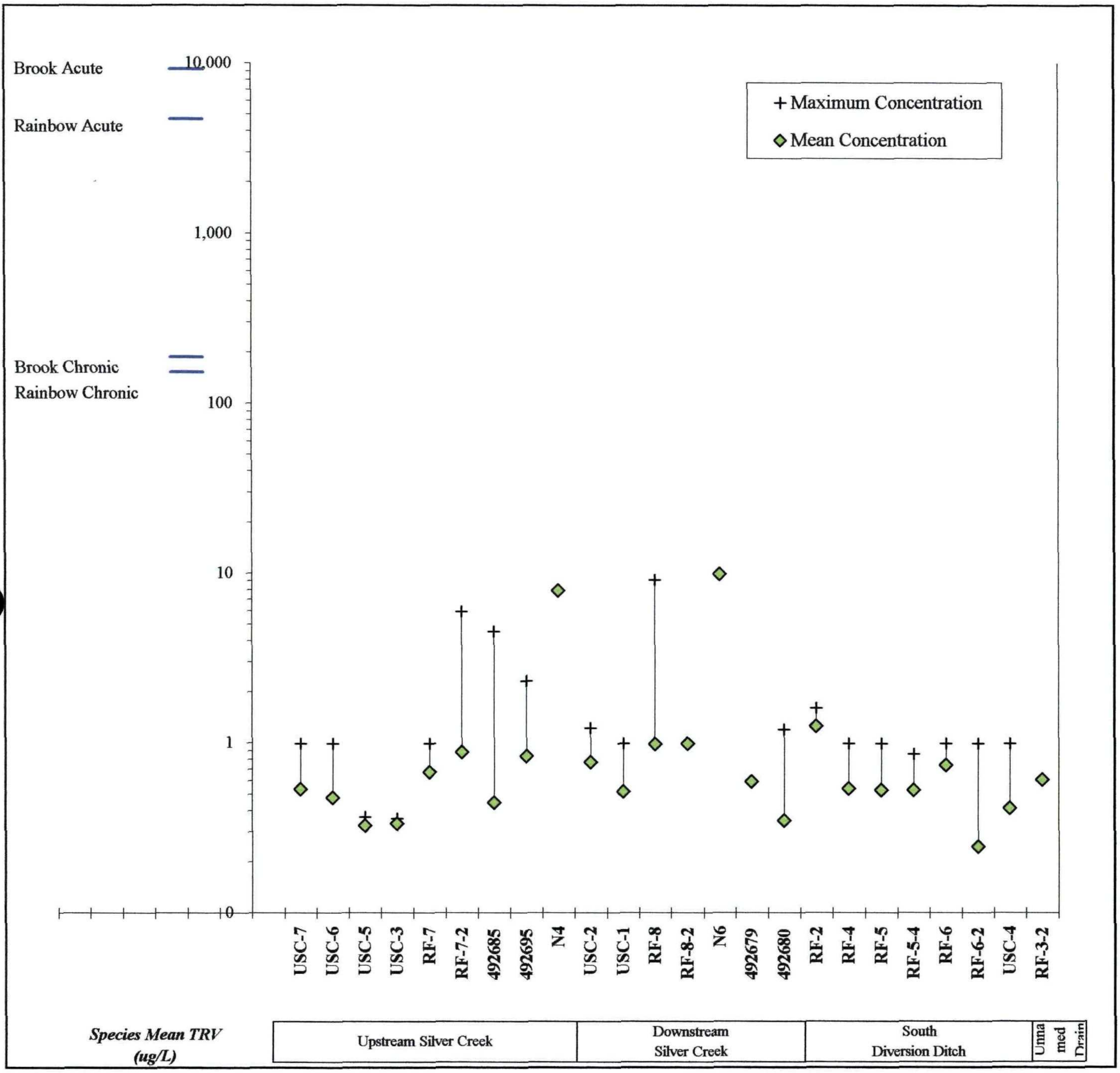
Concentrations and TRVs are in units of ug/L
All toxicity values calculated at hardness = 100mg/L
All concentration values normalized to hardness = 100mg/L
If station-specific hardness measurements were not available, the average site hardness of 200 mg/L was assumed.

DRAFT

Figure 7-3b

Comparison of Dissolved Lead Concentrations with Species Mean Acute and Chronic Values for Fish

Screening Level Ecological Risk Assessment for Richardson Flat Tailings



Concentrations and TRVs are in units of ug/L

All toxicity values calculated at hardness = 100mg/L

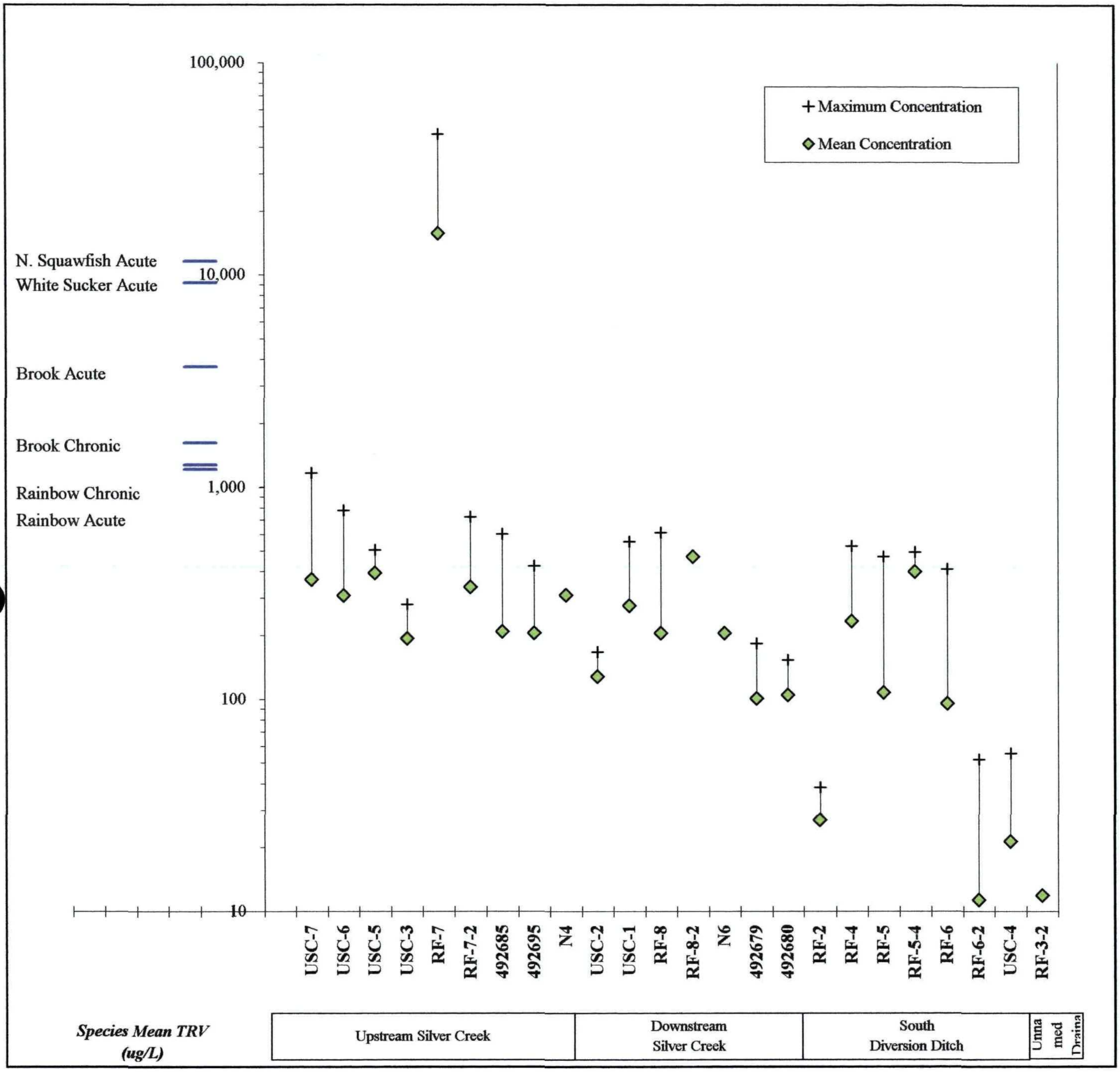
All concentration values normalized to hardness = 100mg/L

If station-specific hardness measurements were not available, the average site hardness of 200 mg/L was assumed.

Figure 7-3c

Comparison of Dissolved Zinc Cncentrations with Species Mean Acute and Chronic Values for Fish

Screening Level Ecological Risk Assessment for Richardson Flat Tailings Site



Concentrations and TRVs are in units of ug/L

All toxicity values calculated at hardness = 100mg/L

All concentration values normalized to hardness = 100mg/L

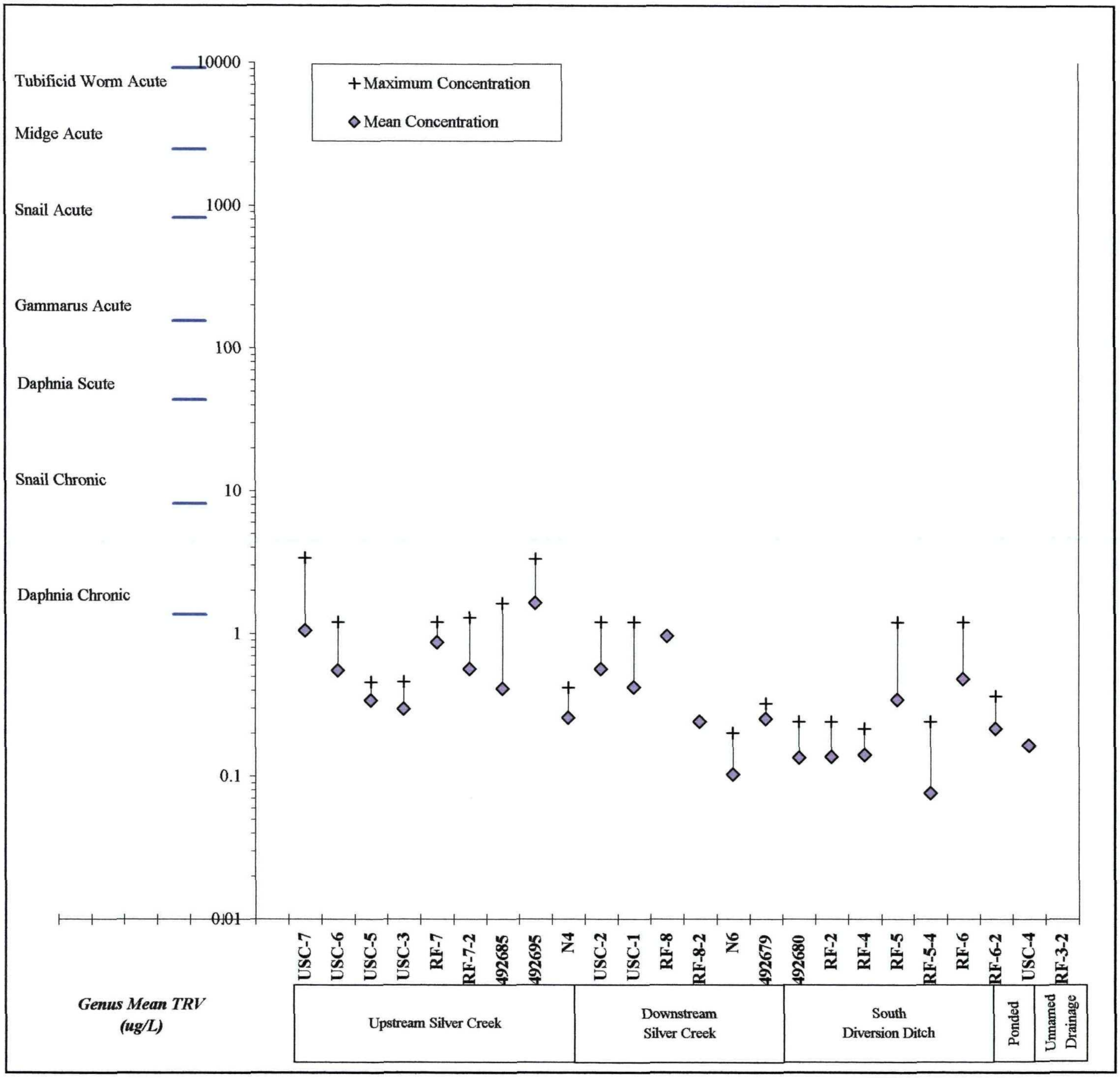
If station-specific hardness measurements were not available, the average site hardness of 200 mg/L was assumed.

DRAFT

Figure 7-4a

Comparison of Dissolved Cadmium Concentrations with Species Mean Acute and Chronic Values for Benthic Invertebrates

Screening Level Ecological Risk Assessment for Richardson Flat Tailings



Concentrations and TRVs are in units of ug/L

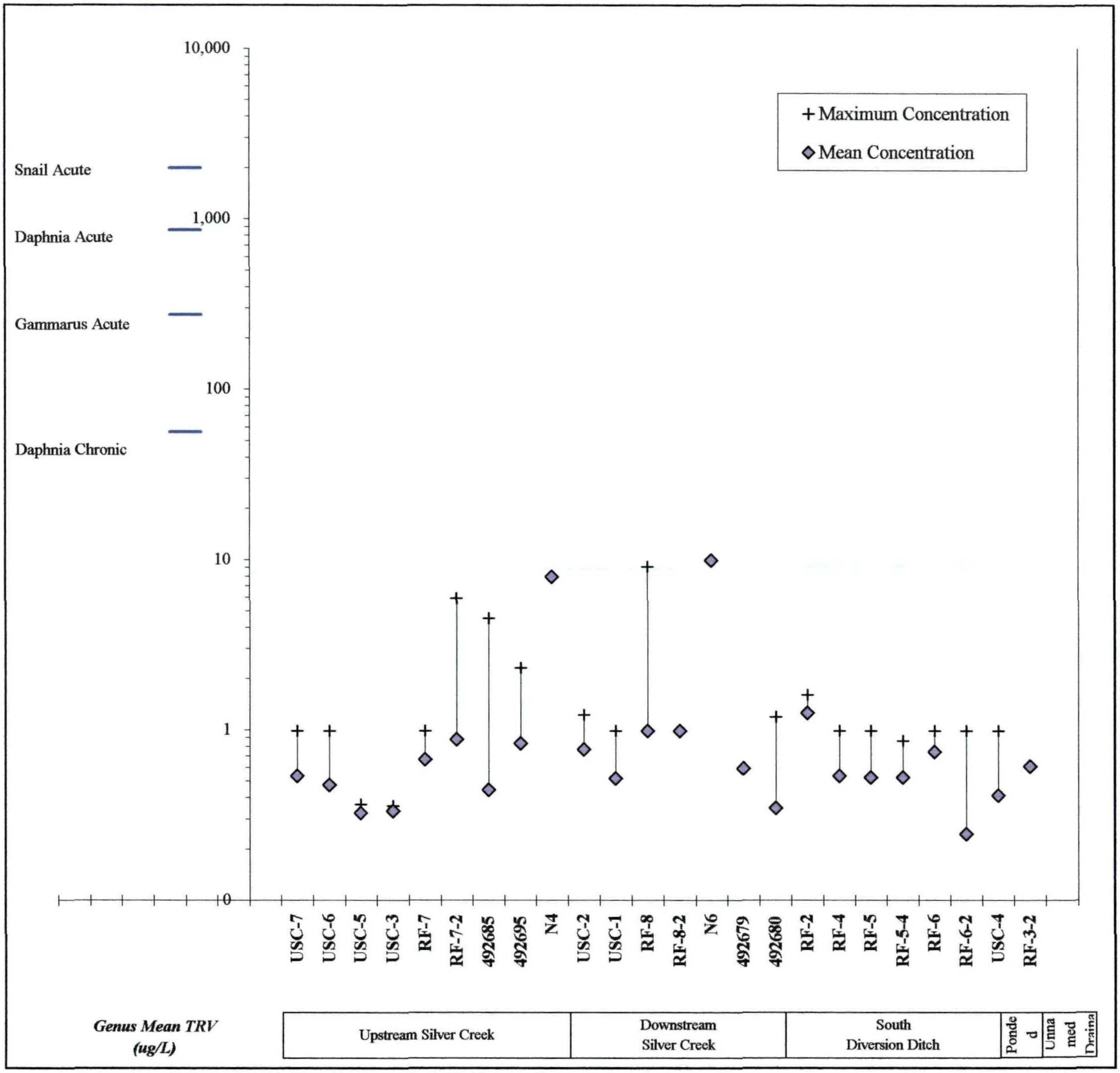
All toxicity values calculated at hardness = 100mg/L

All concentration values normalized to hardness = 100mg/L

If station-specific hardness measurements were not available, the average site hardness of 200 mg/L was assumed.

Figure 7-4b Comparison of Dissolved Lead Concentrations with Genus Mean Acute and Chronic Values for Benthic Invertebrates

Screening Level Ecological Risk Assessment for Richardson Flat Tailings



Concentrations and TRVs are in units of ug/L
All toxicity values calculated at hardness = 100mg/L
All concentration values normalized to hardness = 100mg/L
If station-specific hardness measurements were not available, the average site hardness of 200 mg/L was assumed.

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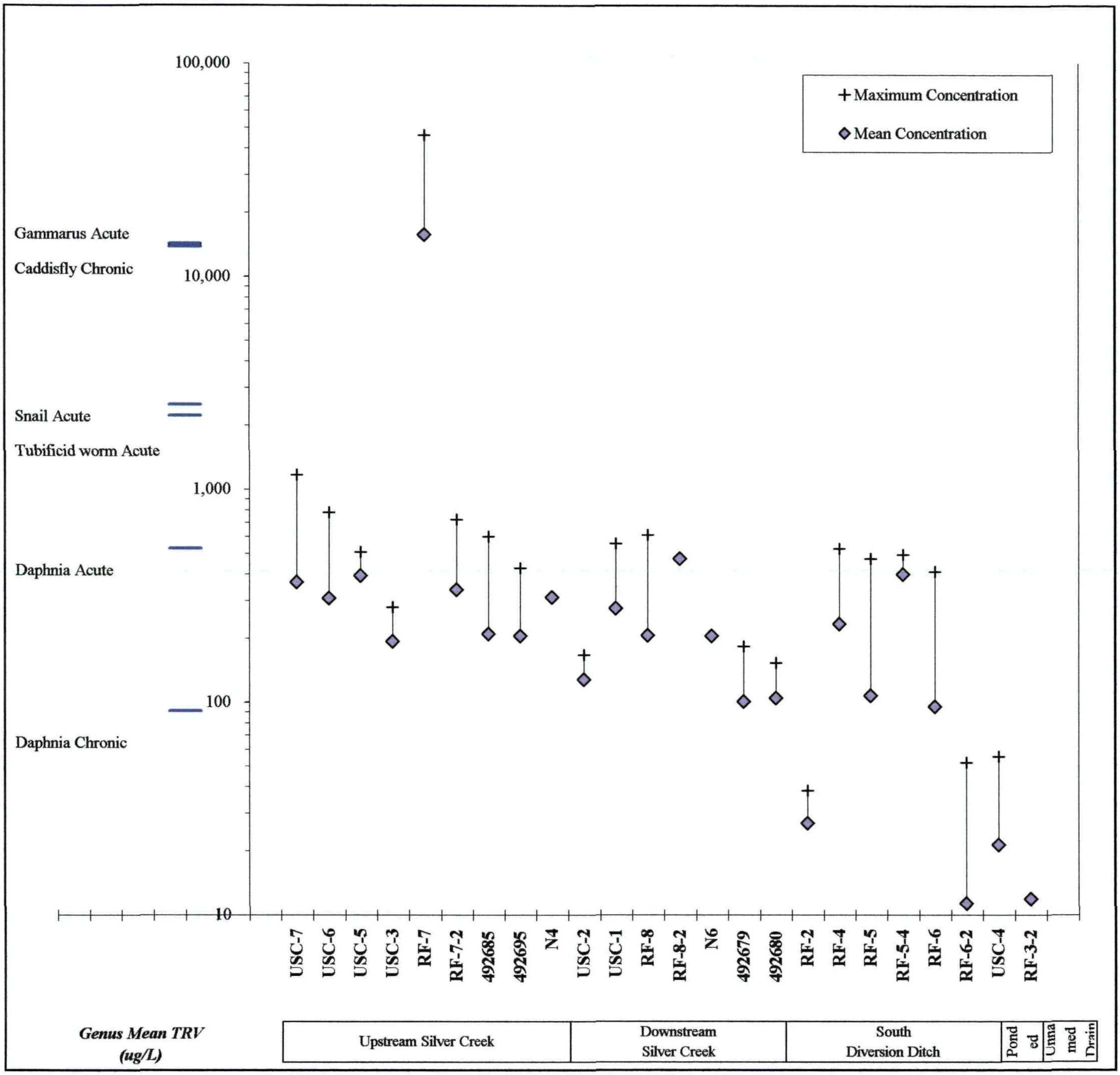
Figure 7-4c

Comparison of Dissolved Zinc Cncentrations with Species Mean Acute and Chronic Values for Fish

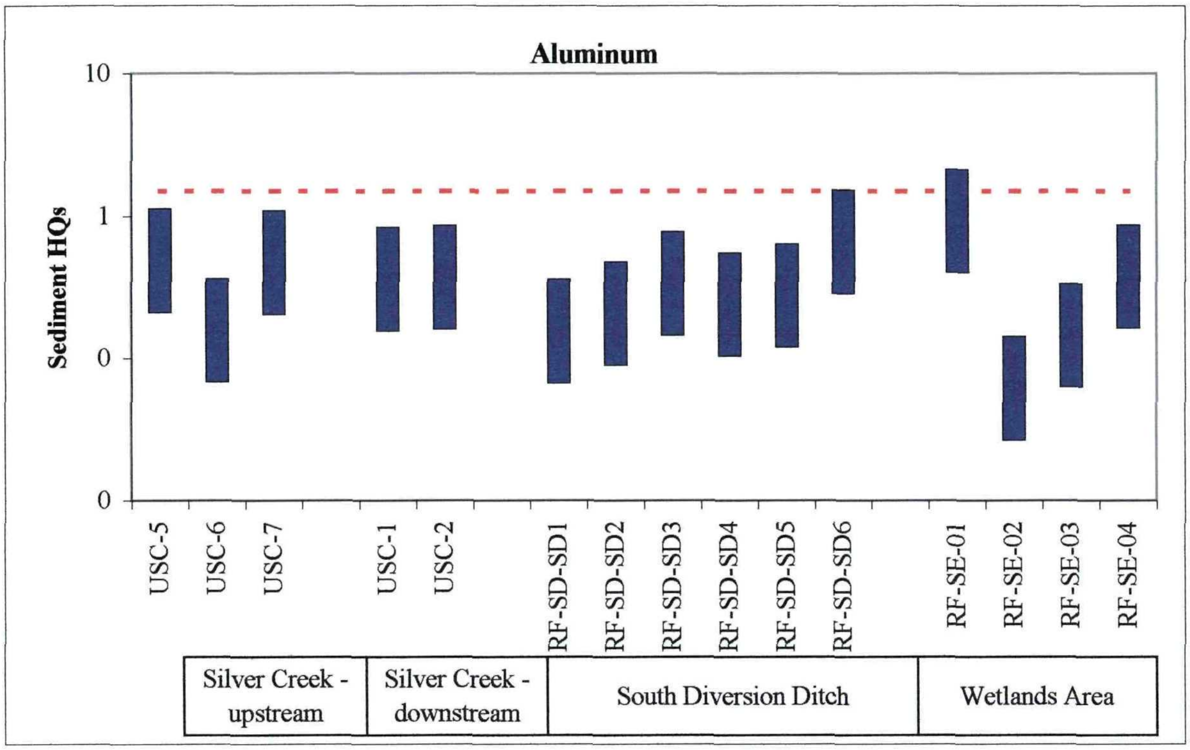
Screening Level Ecological Risk Assessment for Richardson Flat Tailings Site



Concentrations and TRVs are in units of ug/L
All toxicity values calculated at hardness = 100mg/L
All concentration values normalized to hardness = 100mg/L
If station-specific hardness measurements were not available, the average site hardness of 200 mg/L was assumed.

Figure 7-5
Sediment Hazard Quotients (HQs) for Aquatic Receptors

Screening Ecological Risk Assessment for Richardson Flat Tailings



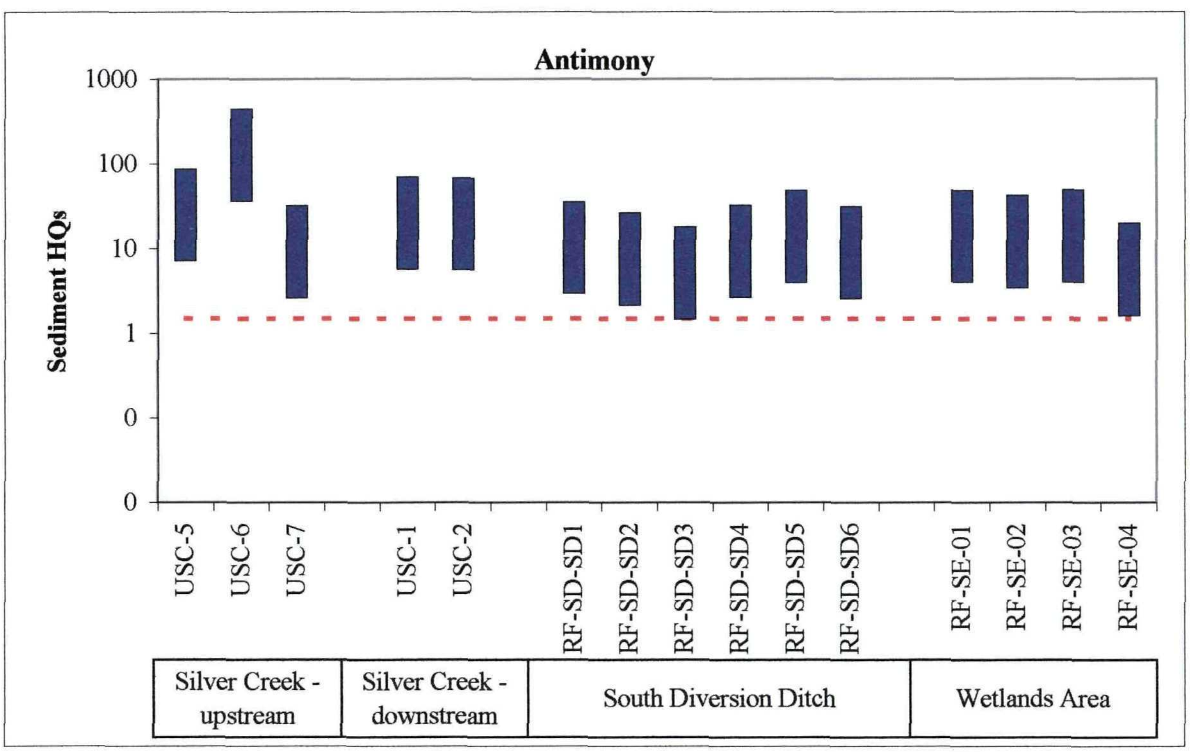
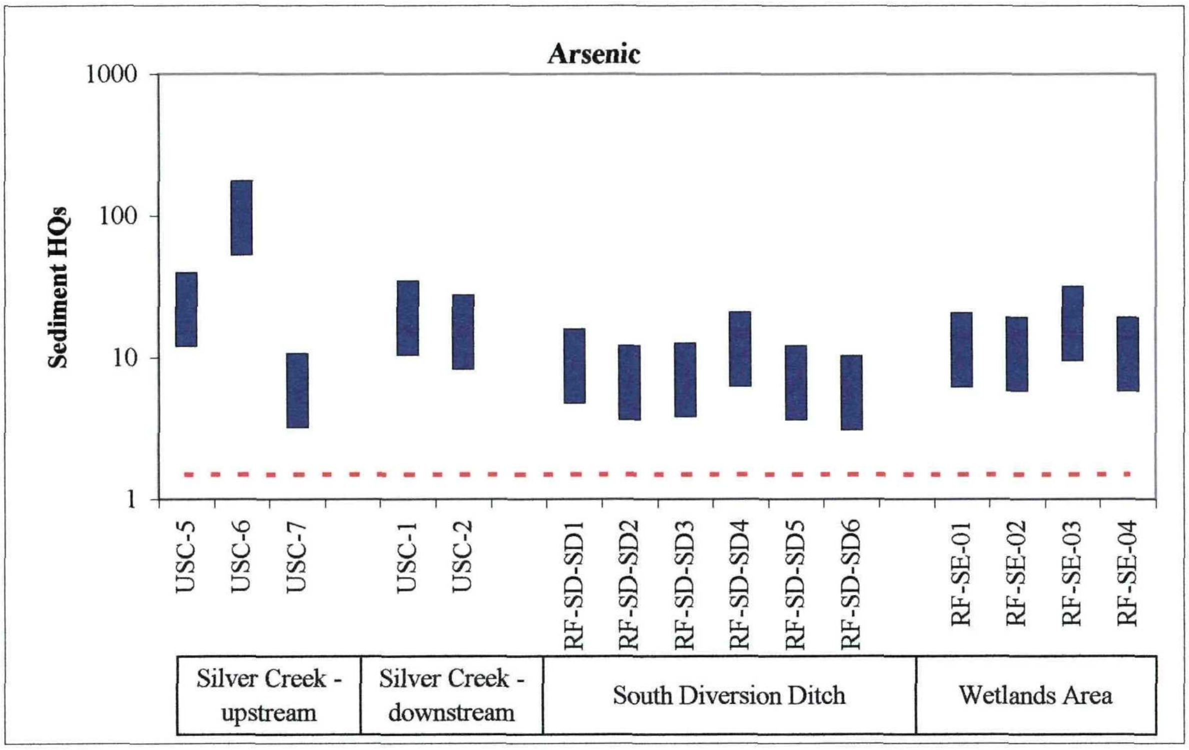


Figure 7-5

Sediment Hazard Quotients (HQs) for Aquatic Receptors

Screening Ecological Risk Assessment for Richardson Flat Tailings



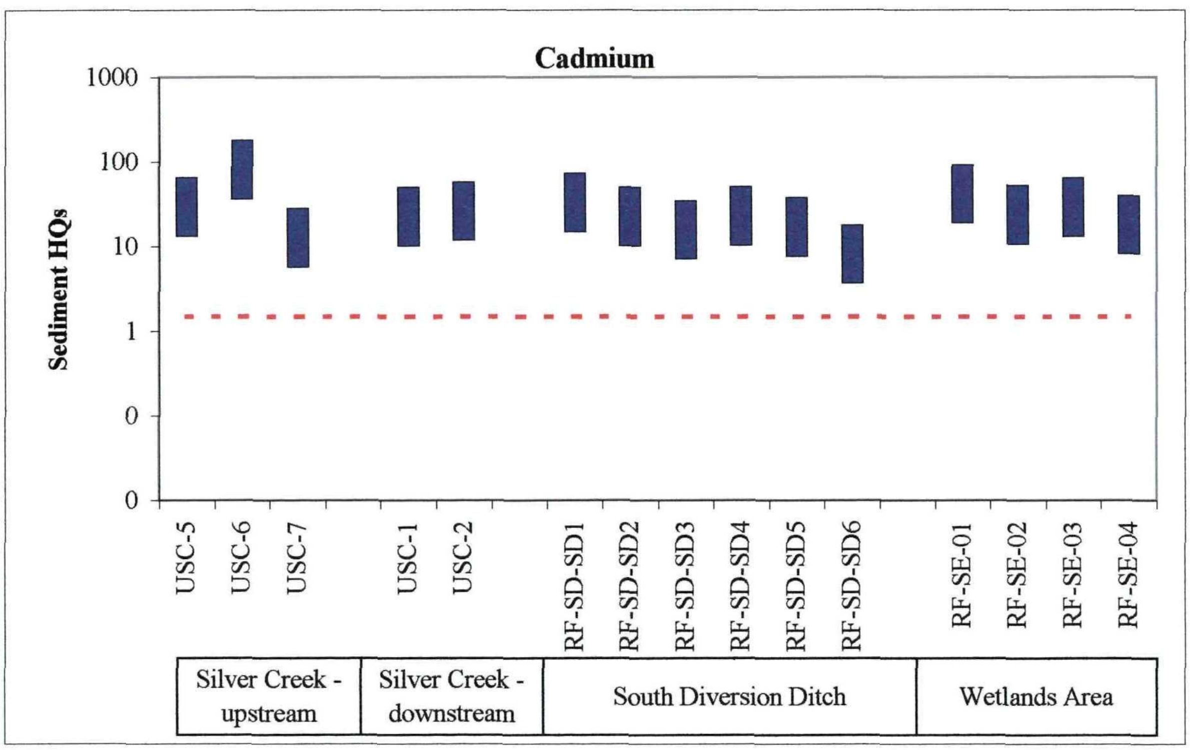
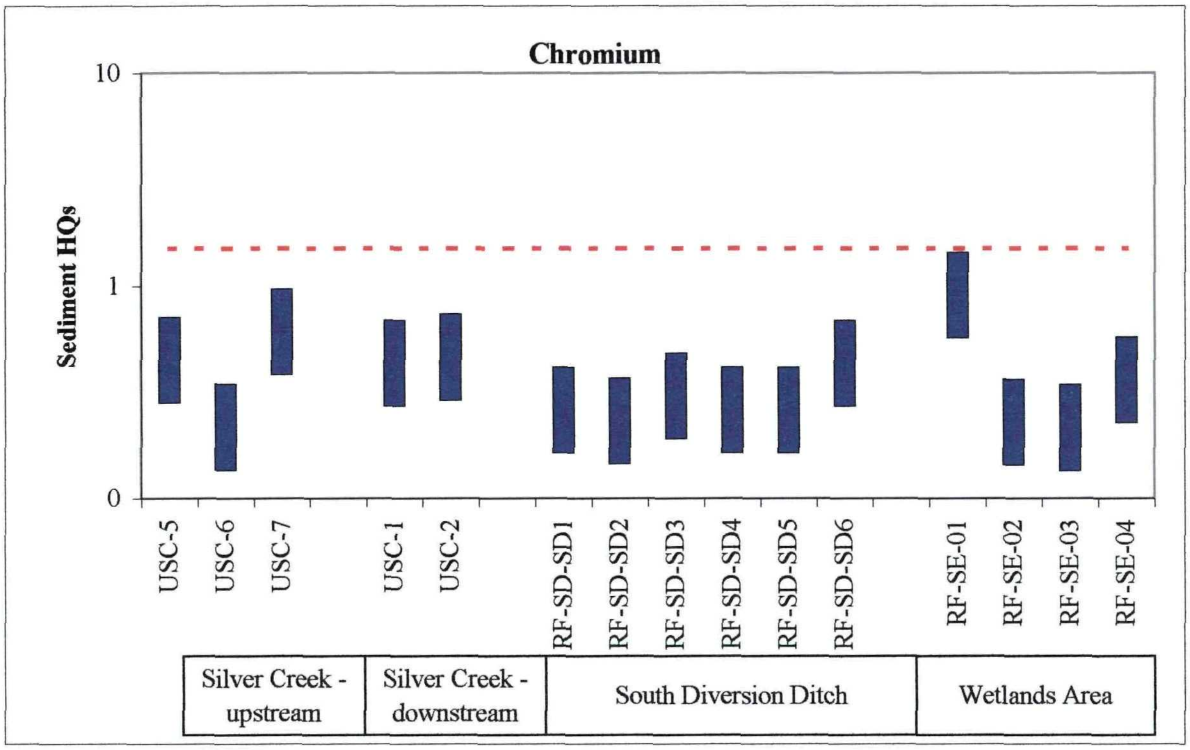


Figure 7-5

Sediment Hazard Quotients (HQs) for Aquatic Receptors

Screening Ecological Risk Assessment for Richardson Flat Tailings



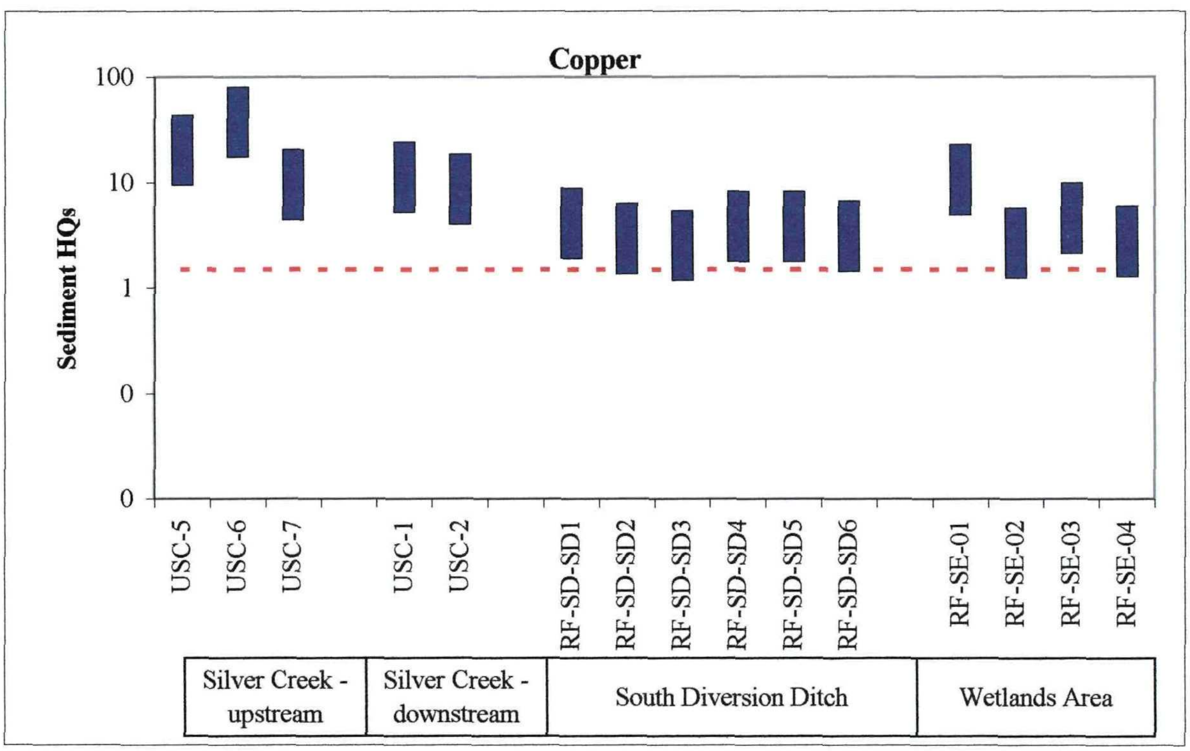
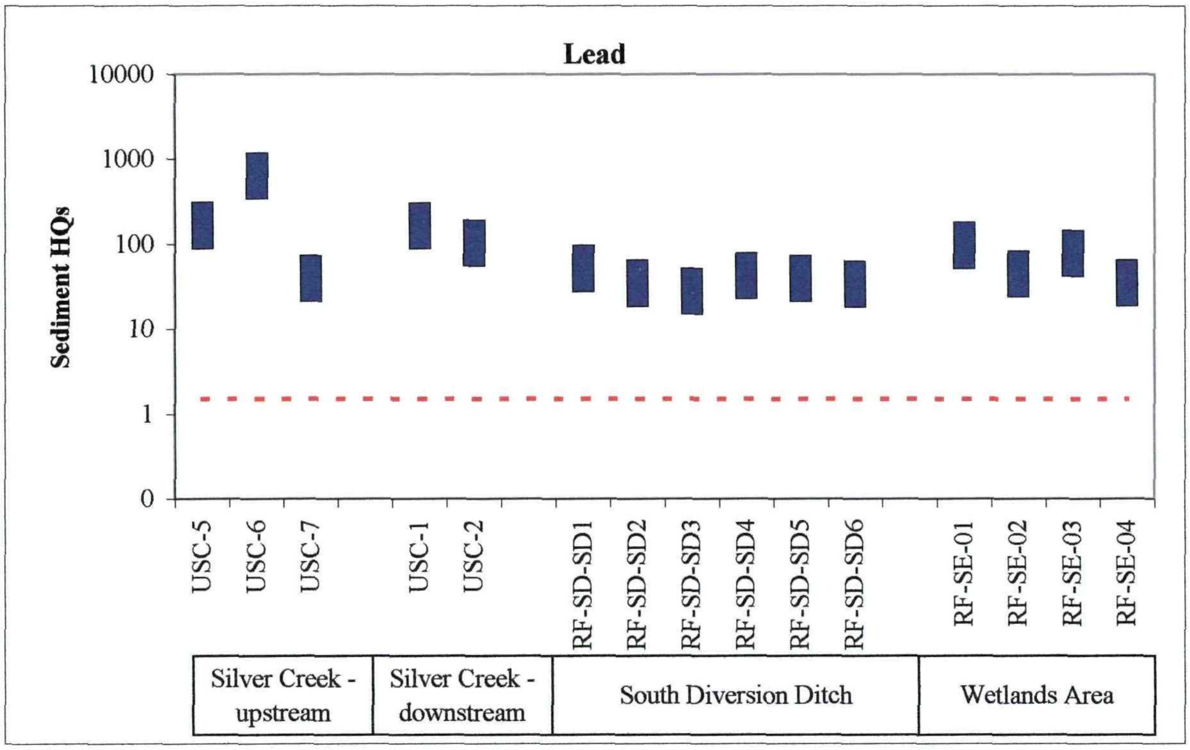


Figure 7-5
Sediment Hazard Quotients (HQs) for Aquatic Receptors

Screening Ecological Risk Assessment for Richardson Flat Tailings



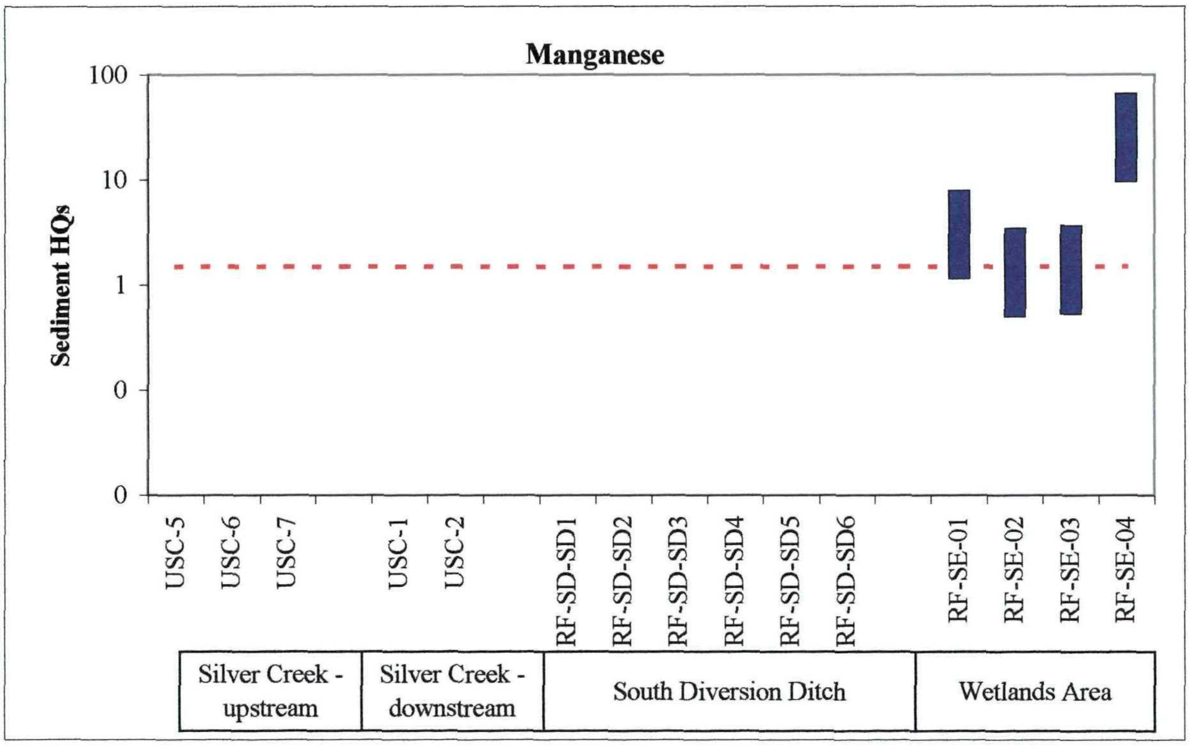
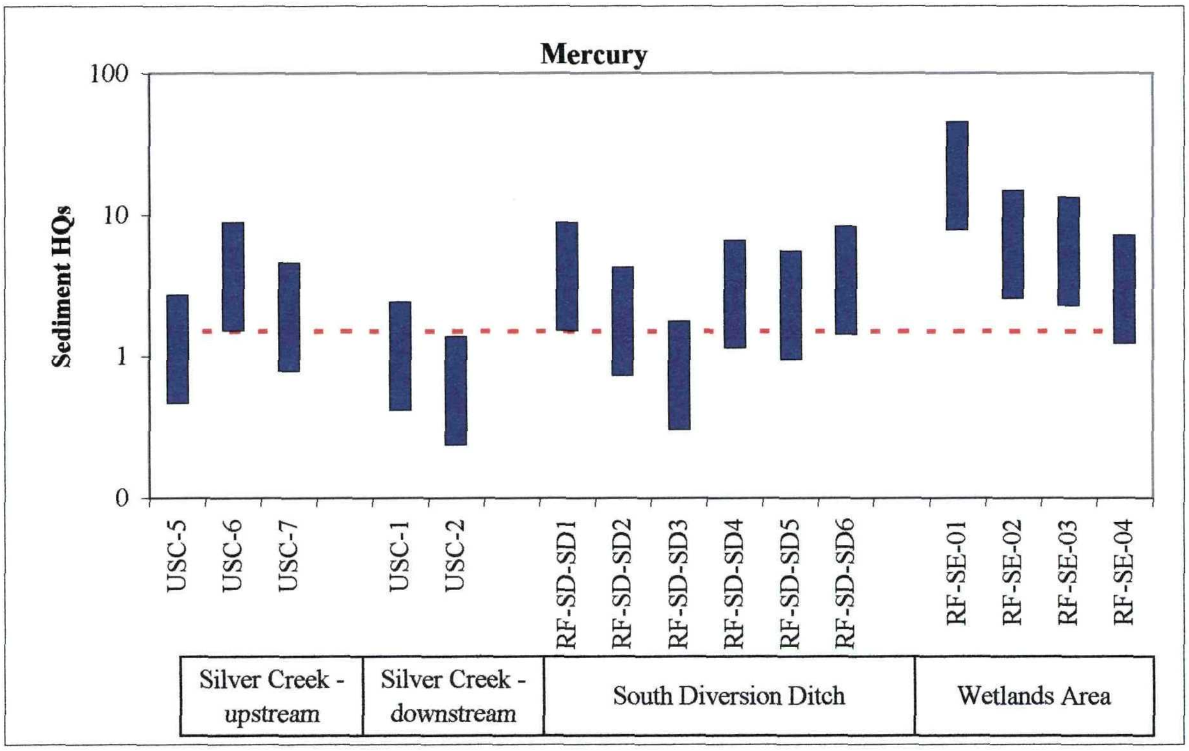


Figure 7-5

Sediment Hazard Quotients (HQs) for Aquatic Receptors

Screening Ecological Risk Assessment for Richardson Flat Tailings



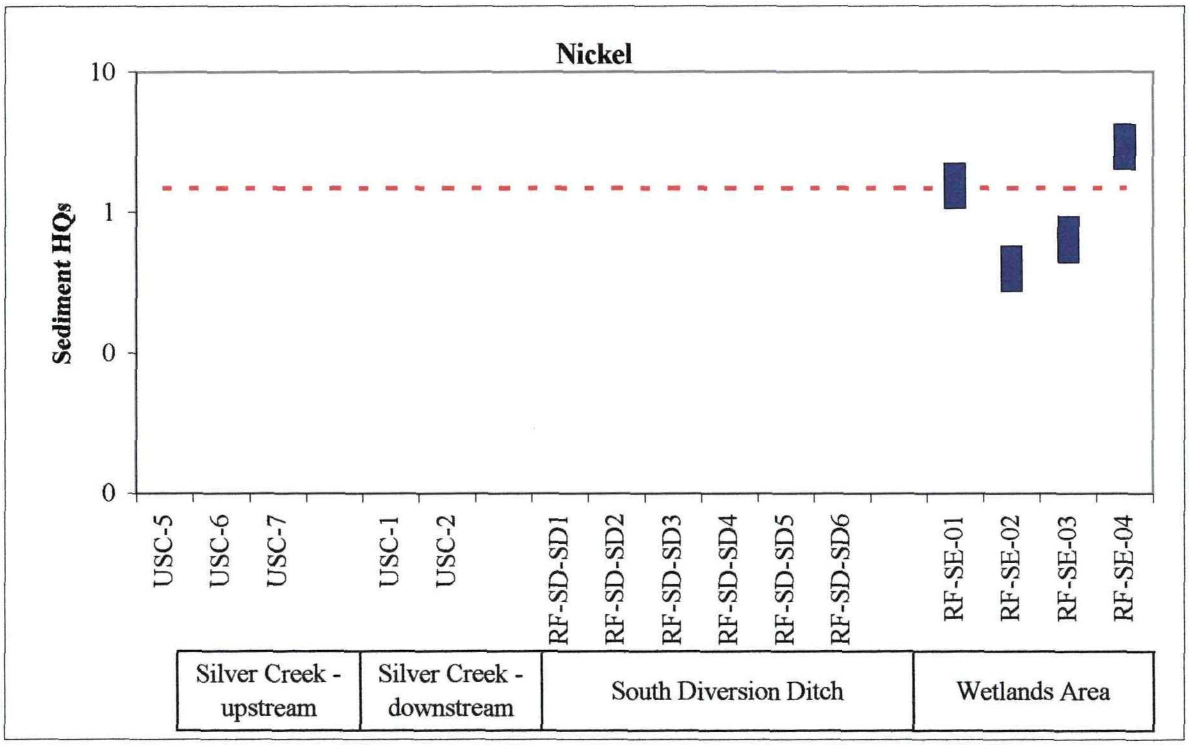
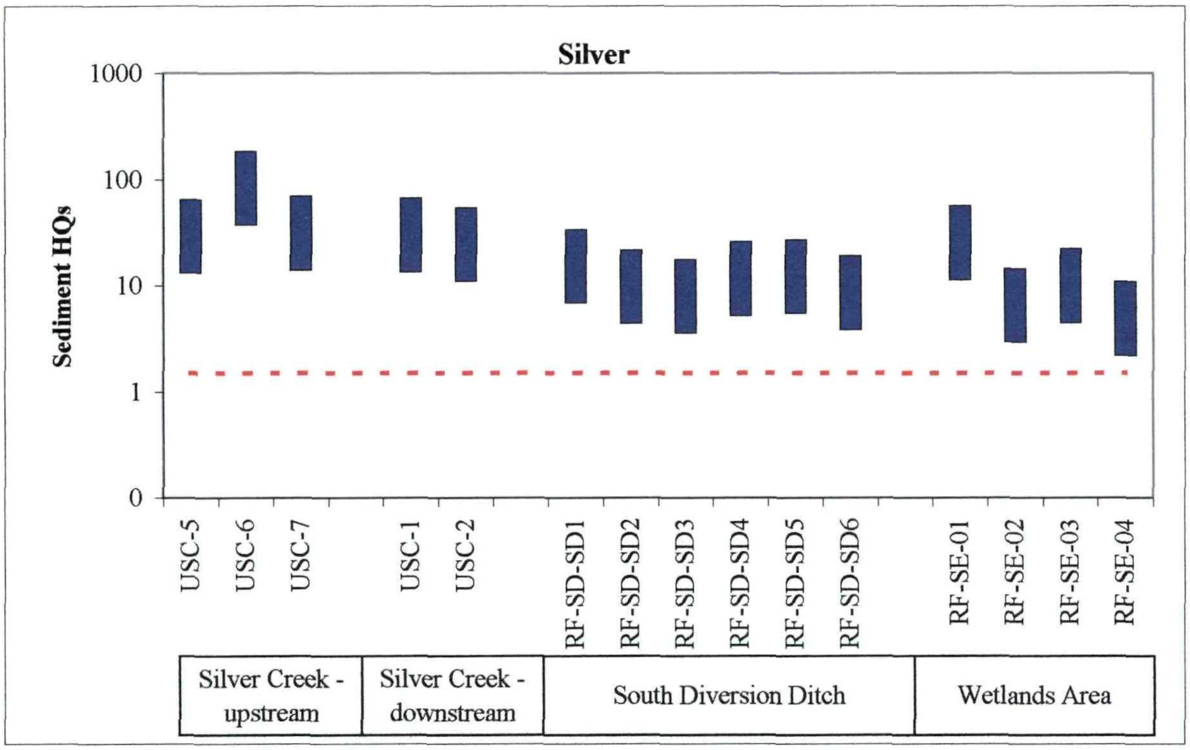


Figure 7-5

Sediment Hazard Quotients (HQs) for Aquatic Receptors

Screening Ecological Risk Assessment for Richardson Flat Tailings



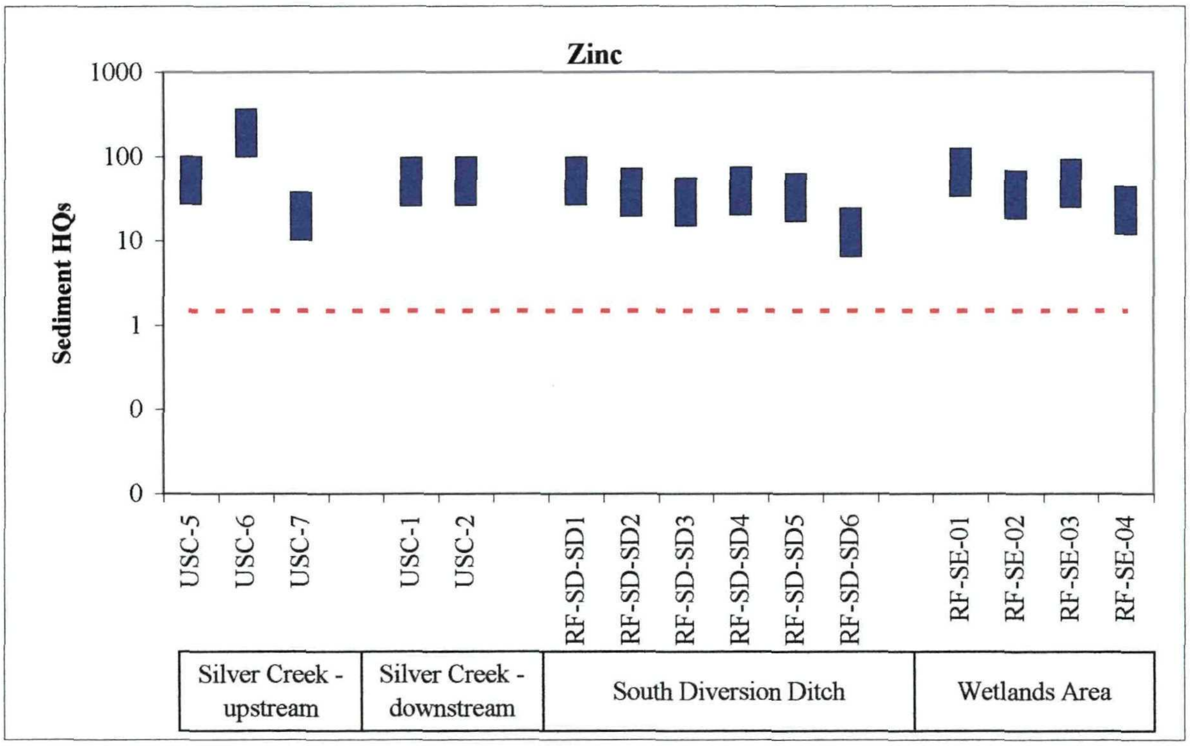
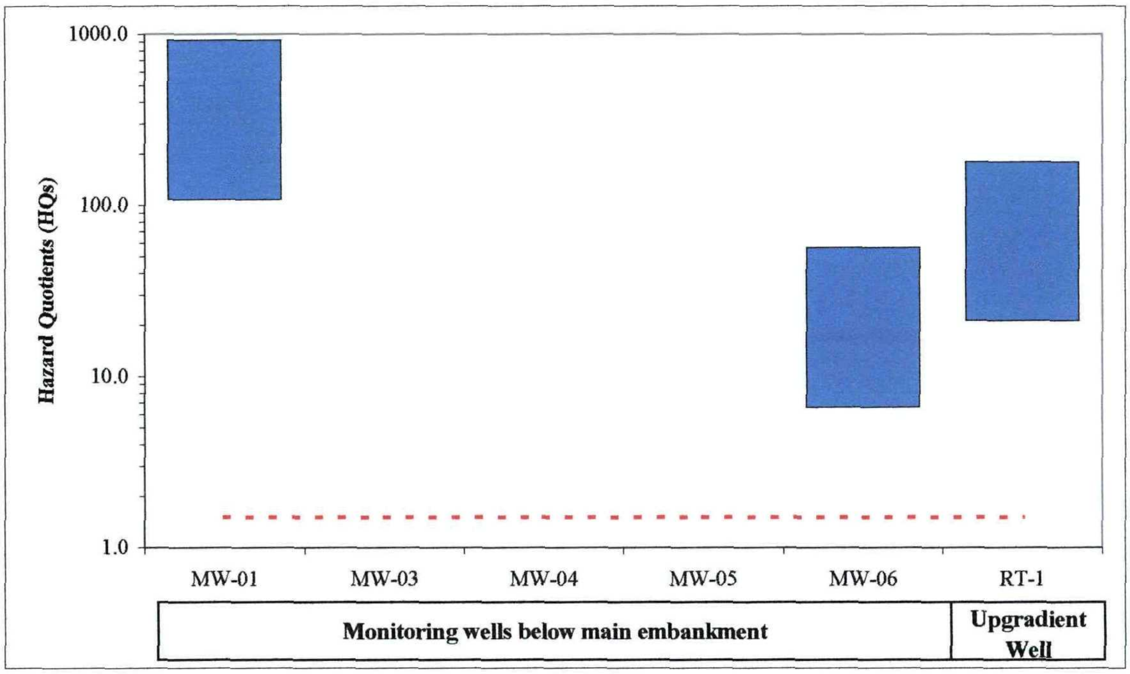


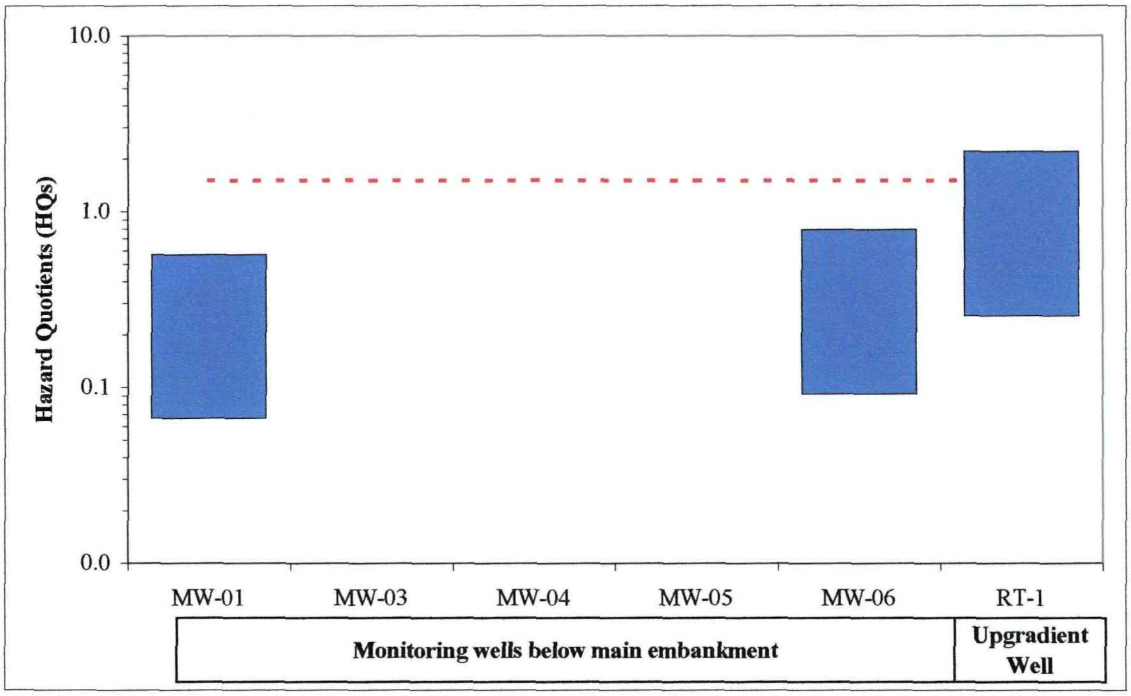
Figure 7-6
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Seeps*

Richardson Flats Tailings Site
Screening Ecological Risk Assessment

TOTAL ALUMINUM



DISSOLVED ALUMINUM



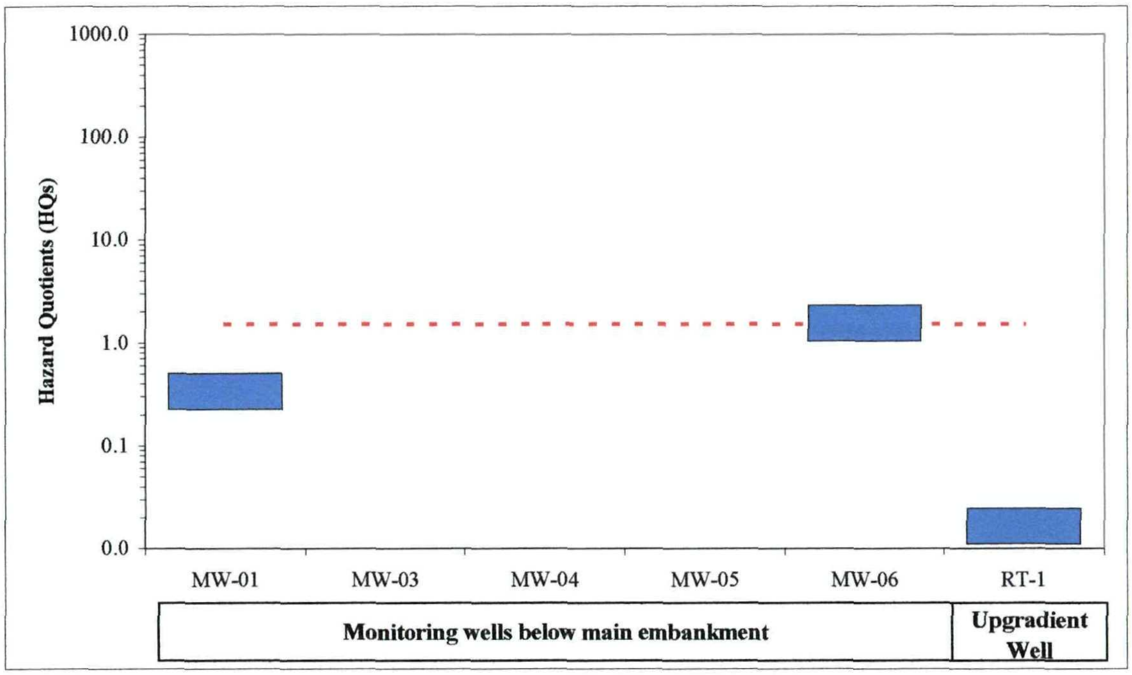
HQ ranges are based on the acute and chronic AWQC.
***Seep concentrations are estimated using available groundwater data.**

DRAFT

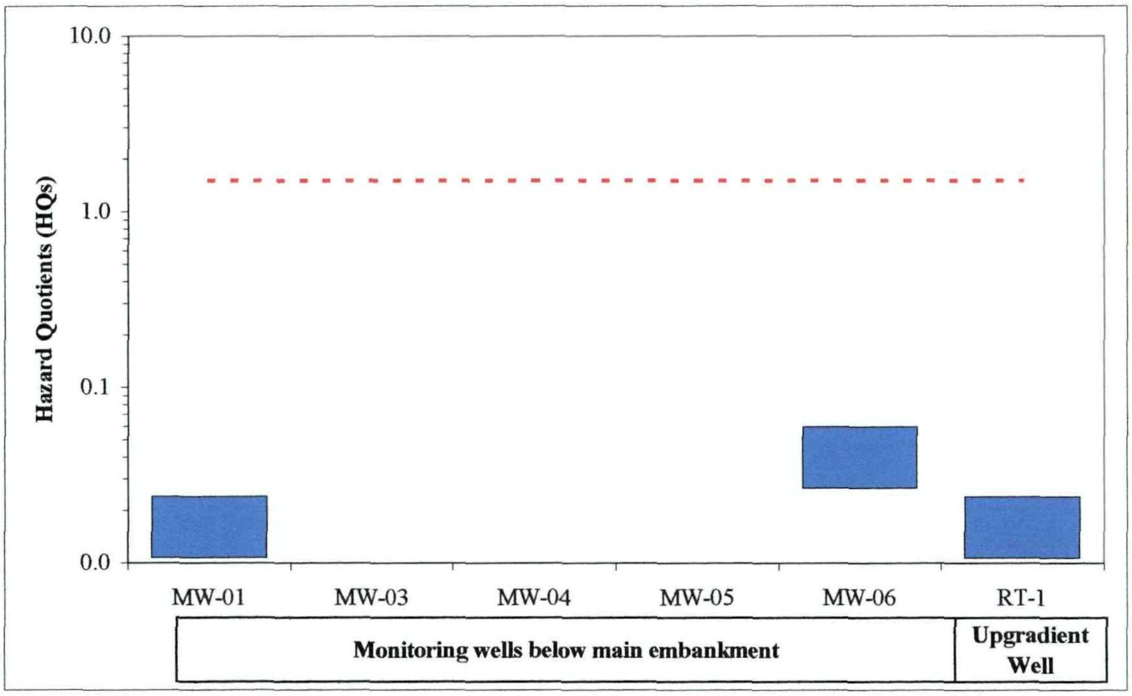
Figure 7-6
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Seeps*

Richardson Flats Tailings Site
Screening Ecological Risk Assessment

TOTAL ARSENIC



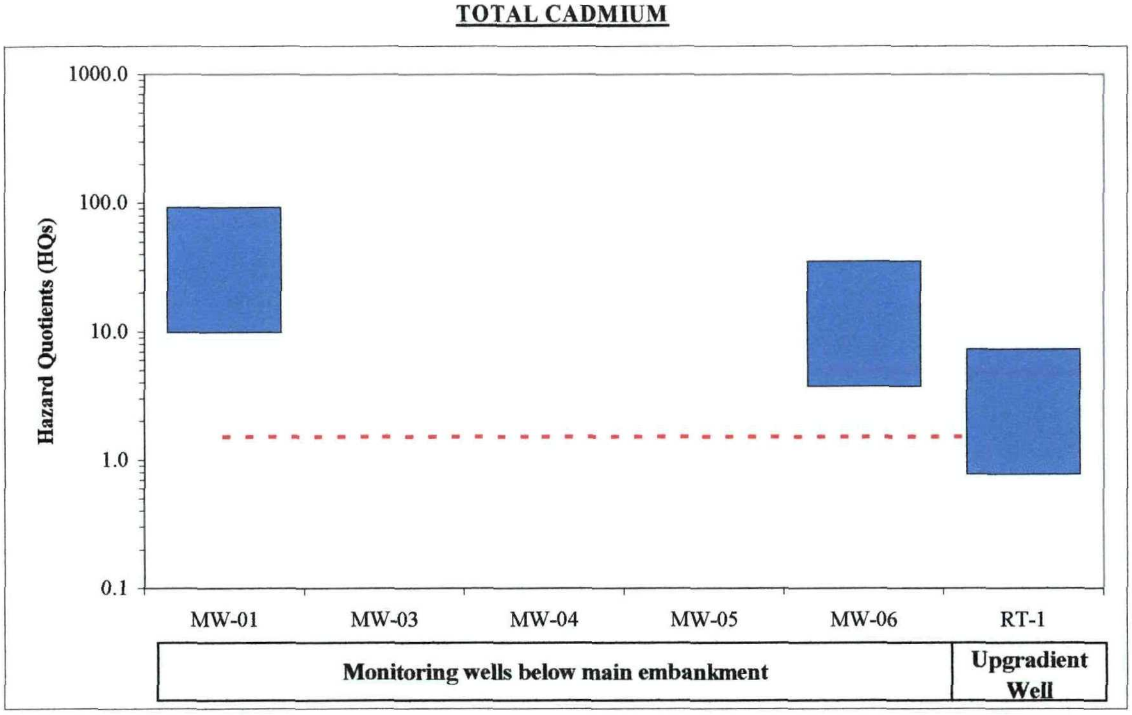
DISSOLVED ARSENIC

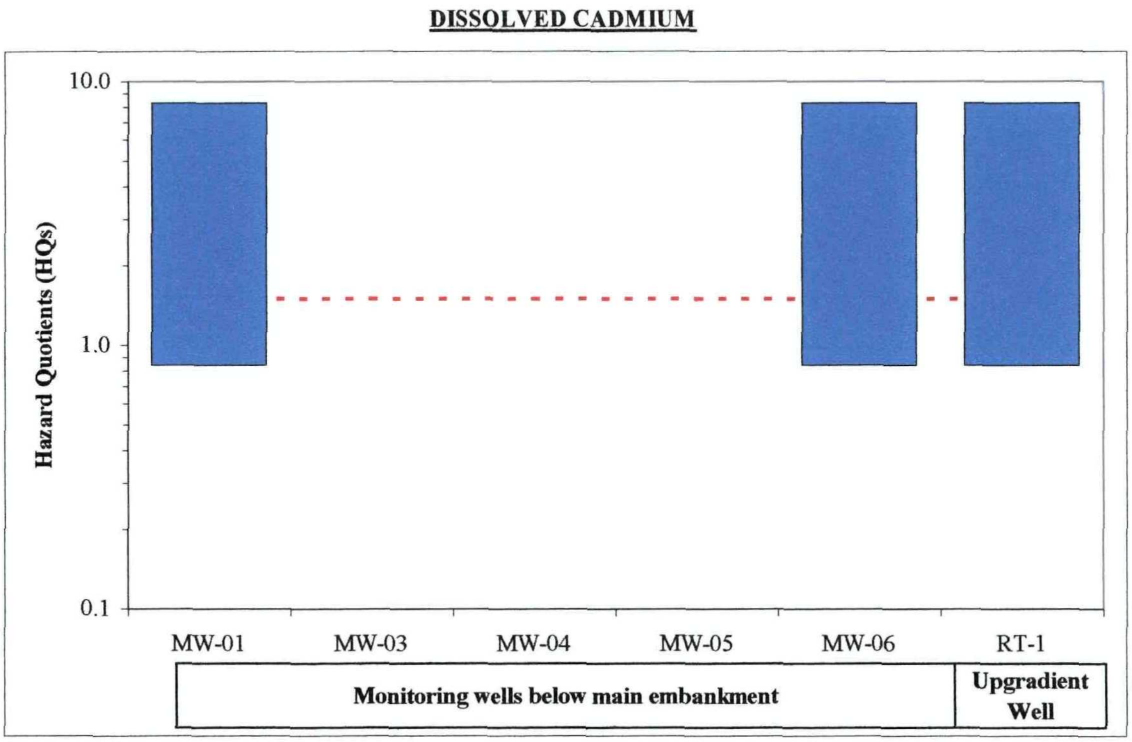


HQ ranges are based on the acute and chronic AWQC.
***Seep concentrations are estimated using available groundwater data.**

Figure 7-6
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Seeps*

Richardson Flats Tailings Site
Screening Ecological Risk Assessment



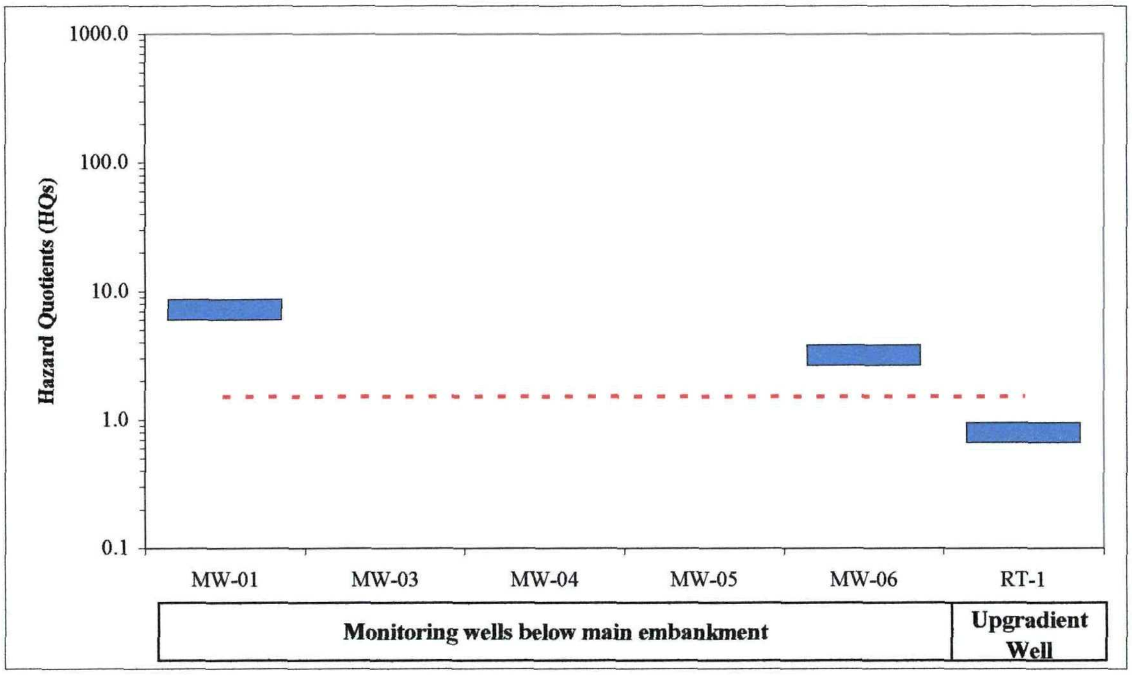


HQ ranges are based on the acute and chronic AWQC.
***Seep concentrations are estimated using available groundwater data.**

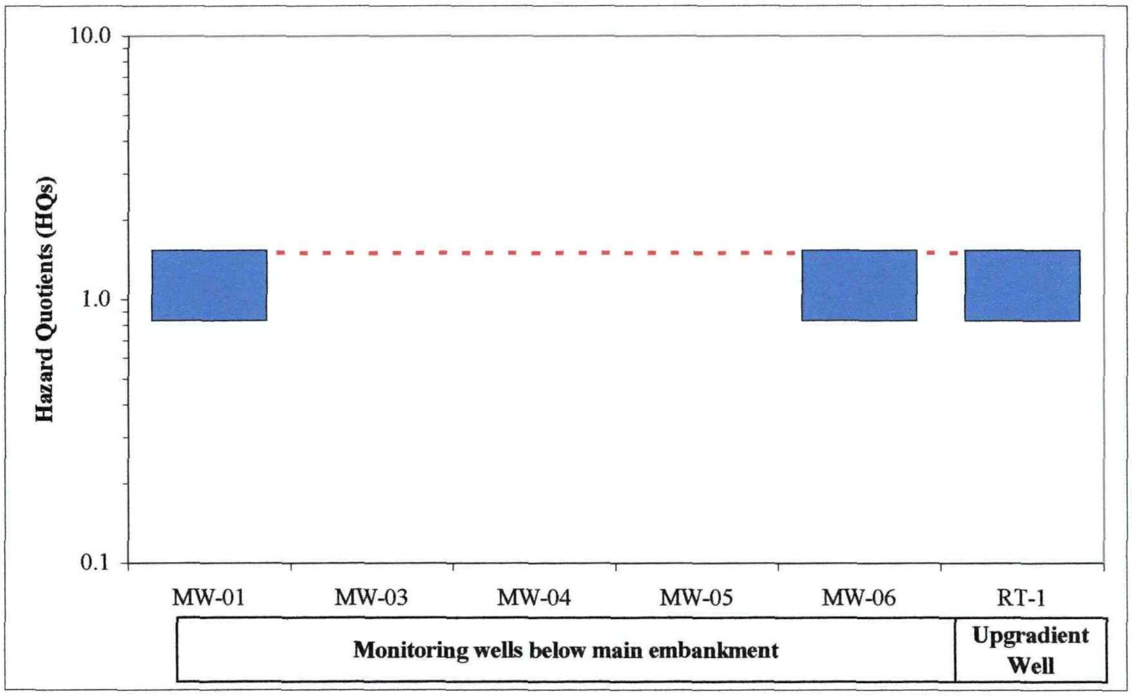
Figure 7-6
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Seeps*

Richardson Flats Tailings Site
Screening Ecological Risk Assessment

TOTAL CHROMIUM



DISSOLVED CHROMIUM



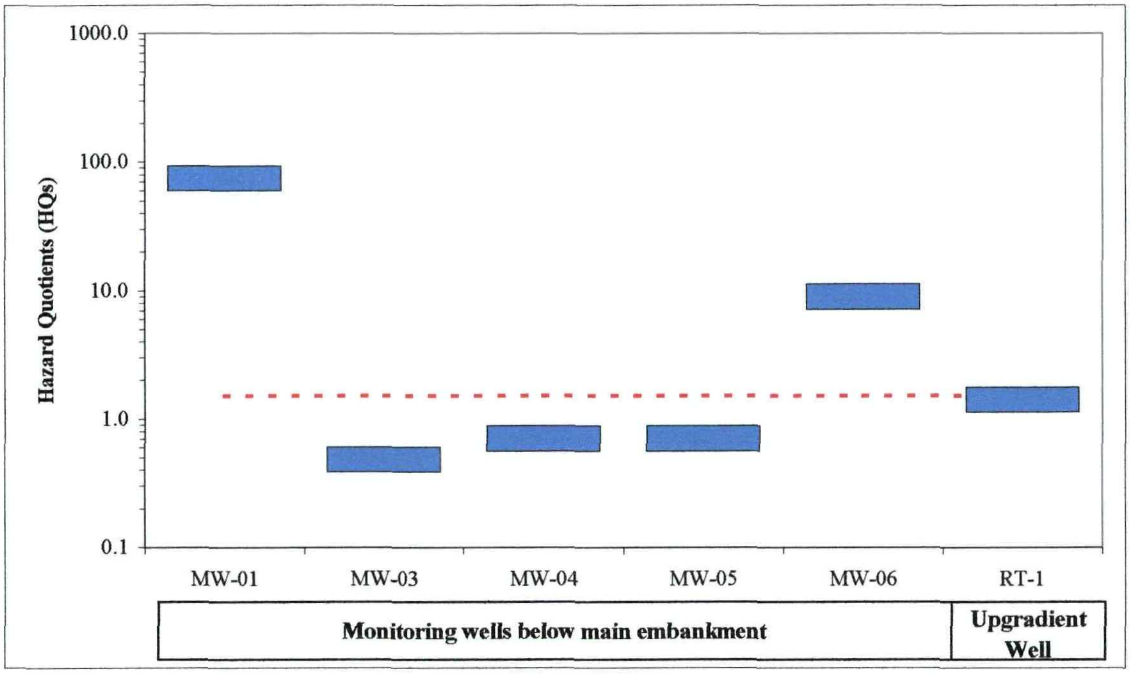
HQ ranges are based on the acute and chronic AWQC.

***Seep concentrations are estimated using available groundwater data.**

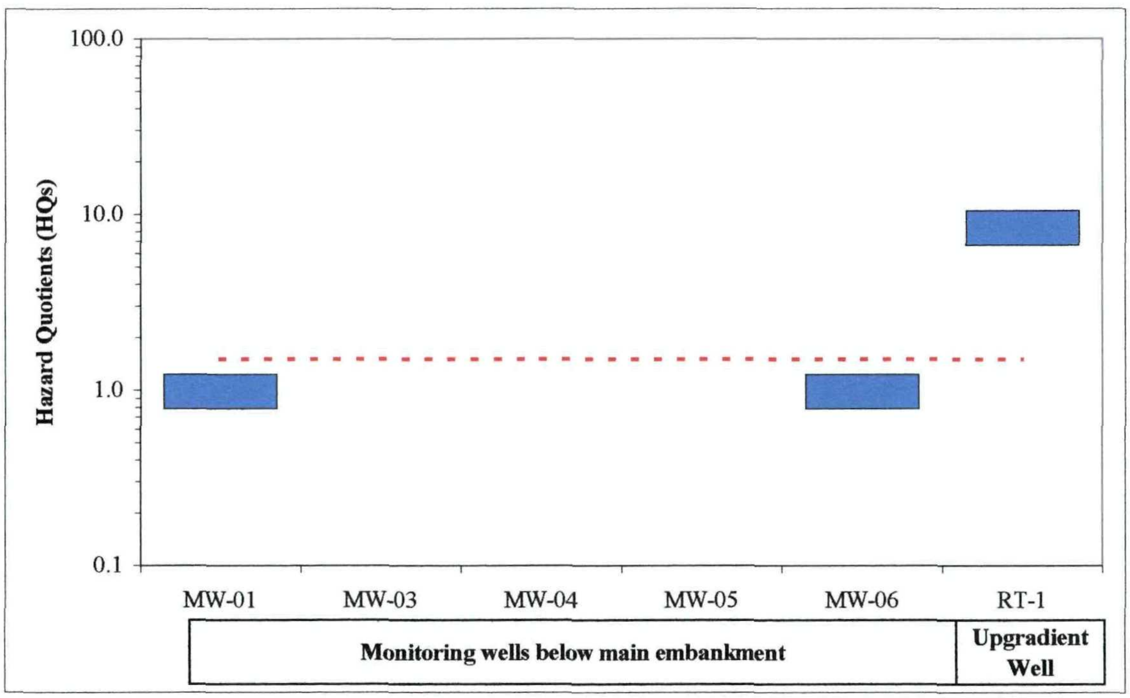
Figure 7-6
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Seeps*

Richardson Flats Tailings Site
Screening Ecological Risk Assessment

TOTAL COPPER



DISSOLVED COPPER

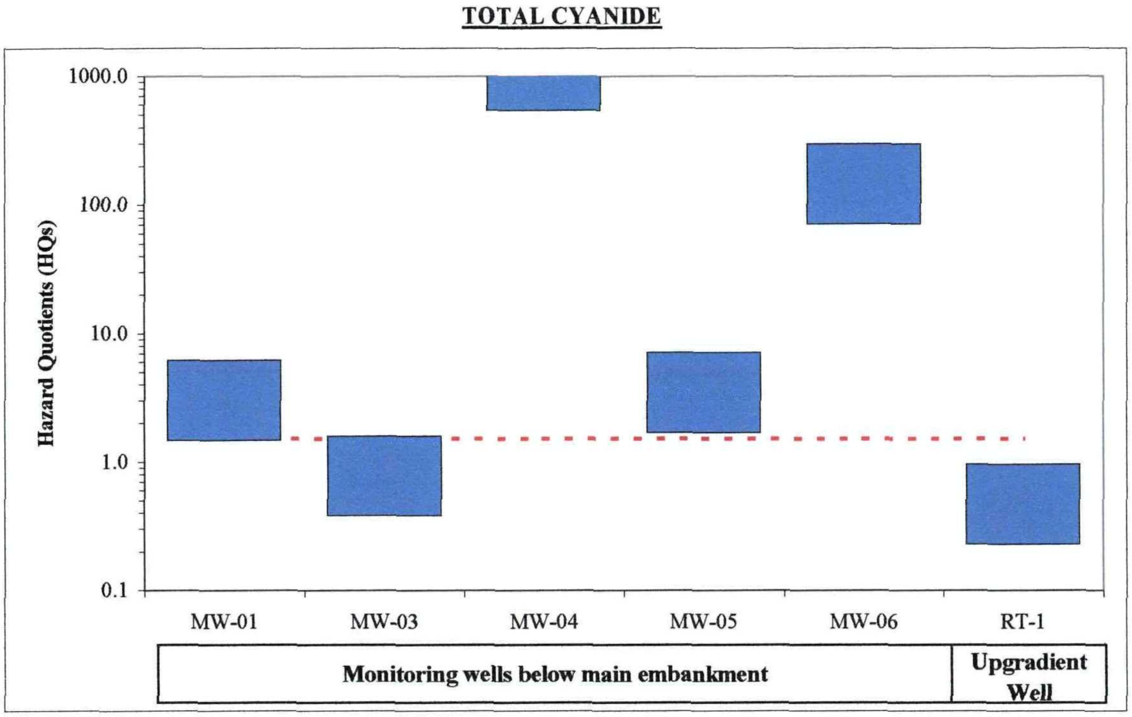


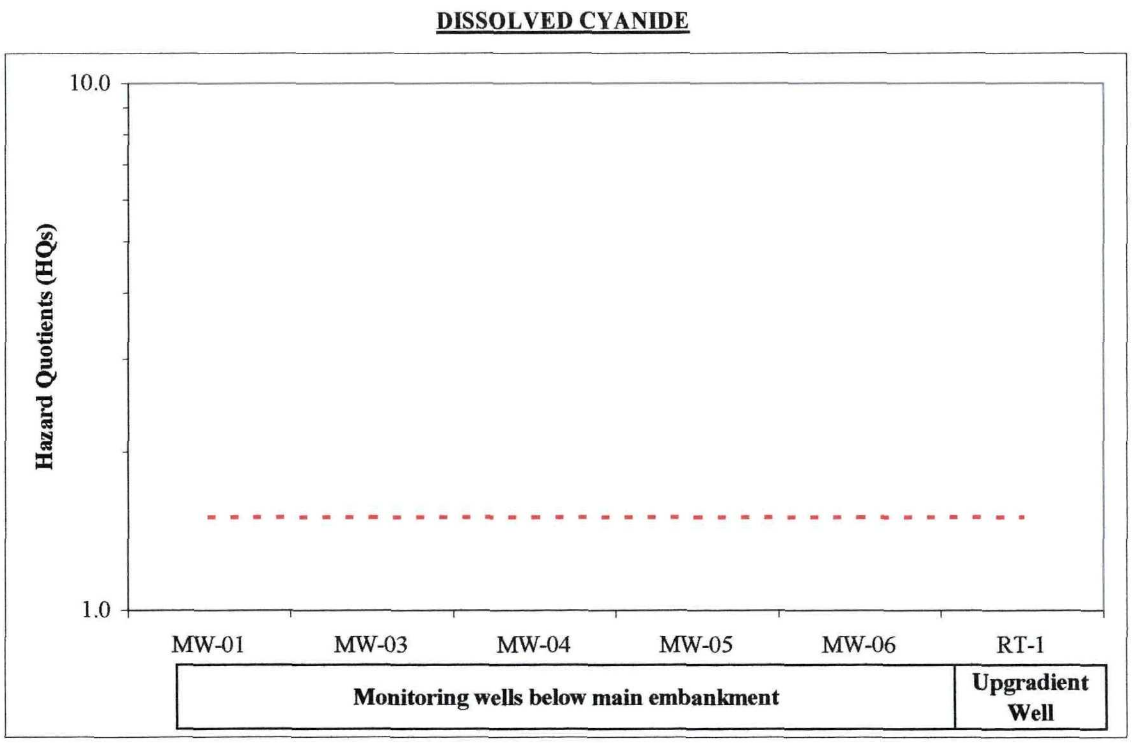
HQ ranges are based on the acute and chronic AWQC.

***Seep concentrations are estimated using available groundwater data.**

Figure 7-6
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Seeps*

Richardson Flats Tailings Site
Screening Ecological Risk Assessment



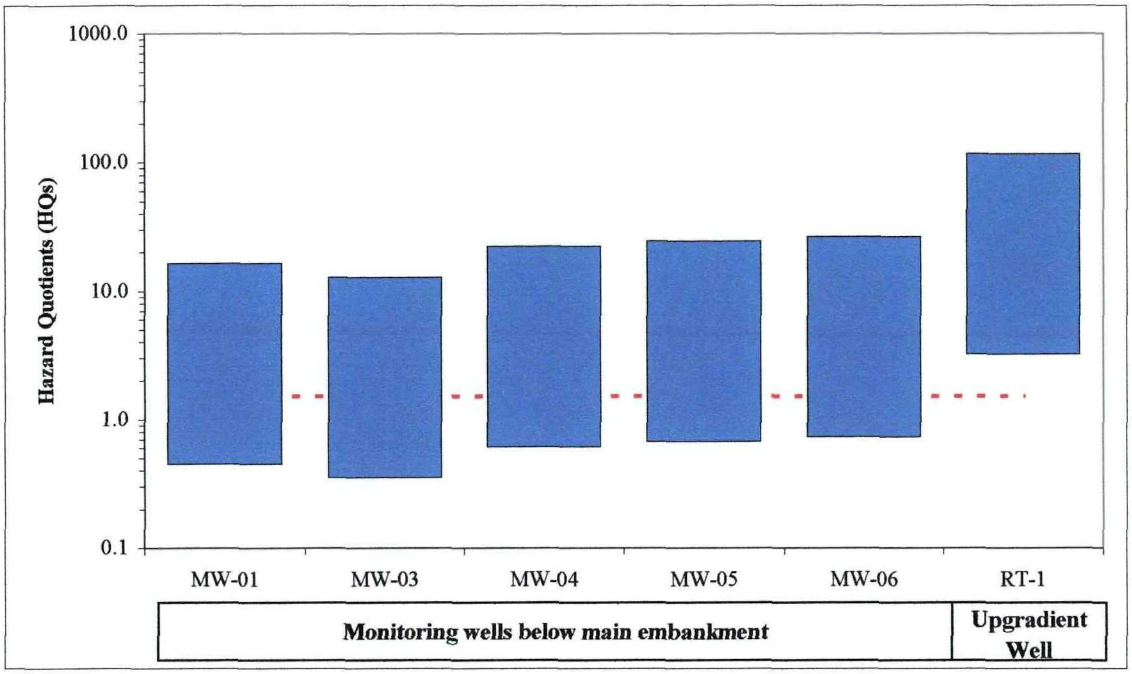


HQ ranges are based on the acute and chronic AWQC.
***Seep concentrations are estimated using available groundwater data.**

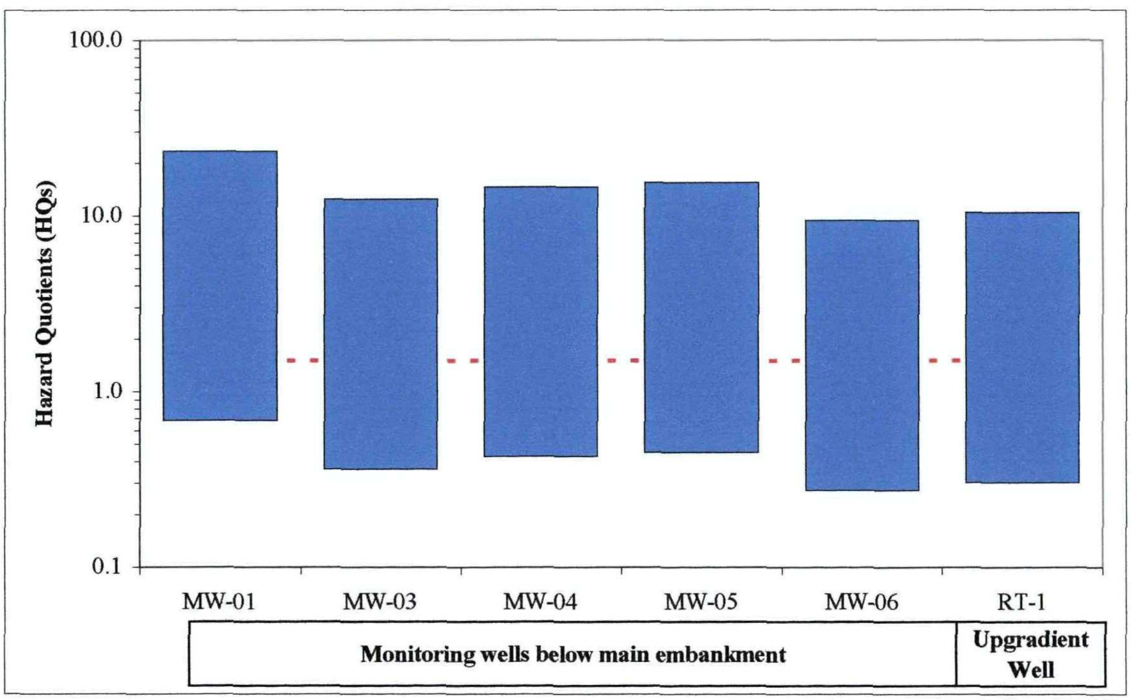
Figure 7-6
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Seeps*

Richardson Flats Tailings Site
Screening Ecological Risk Assessment

TOTAL LEAD



DISSOLVED LEAD



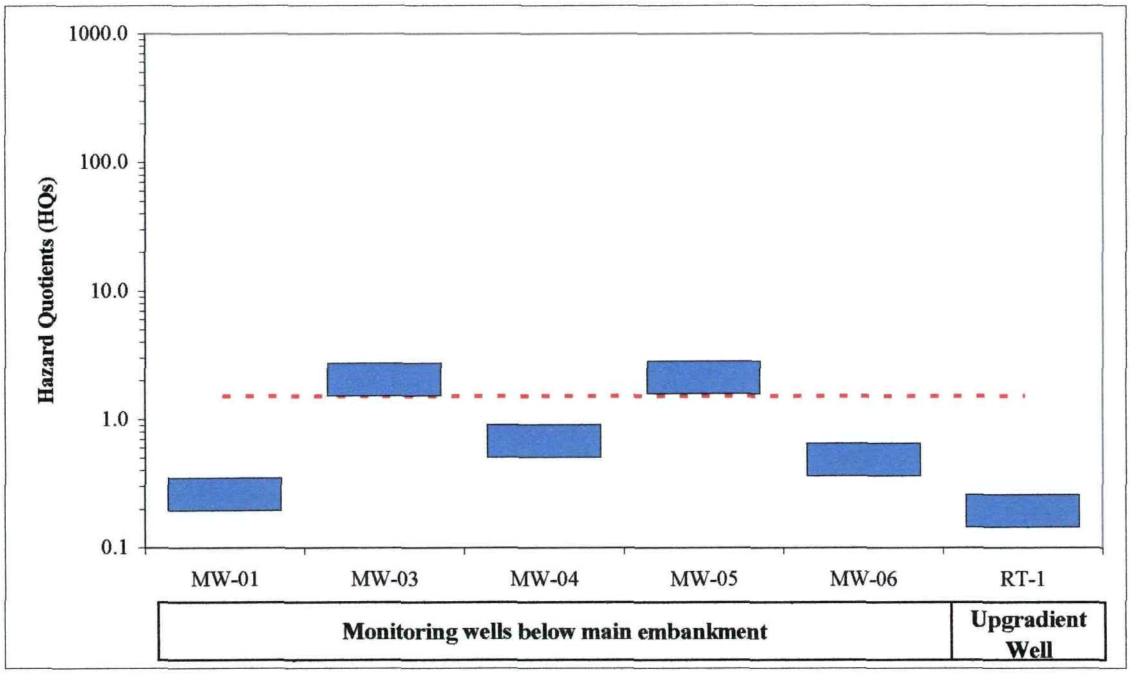
HQ ranges are based on the acute and chronic AWQC.

***Seep concentrations are estimated using available groundwater data.**

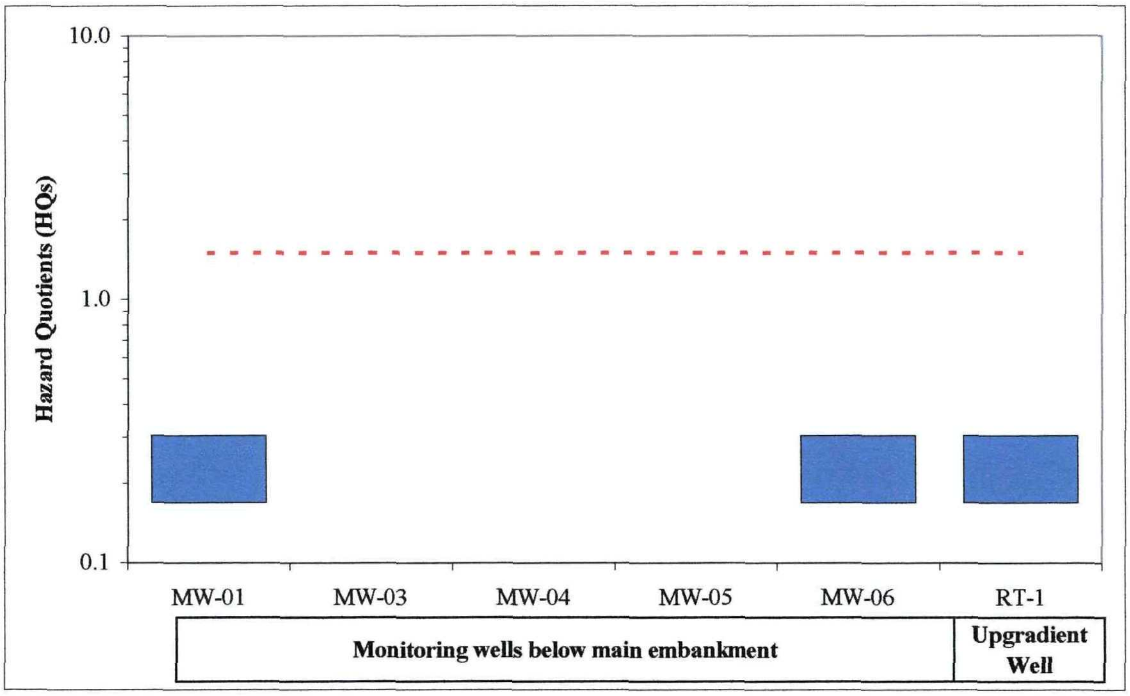
Figure 7-6
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Seeps*

Richardson Flats Tailings Site
Screening Ecological Risk Assessment

<u>**TOTAL MERCURY**</u>



<u>**DISSOLVED MERCURY**</u>

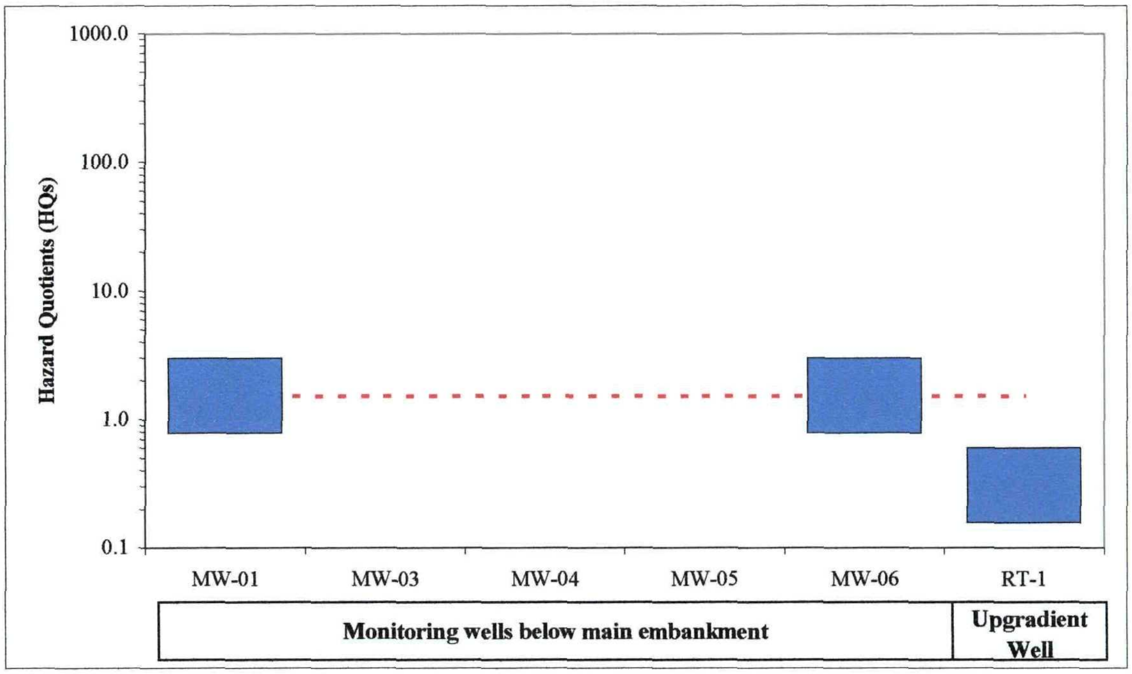


HQ ranges are based on the acute and chronic AWQC.
***Seep concentrations are estimated using available groundwater data.**

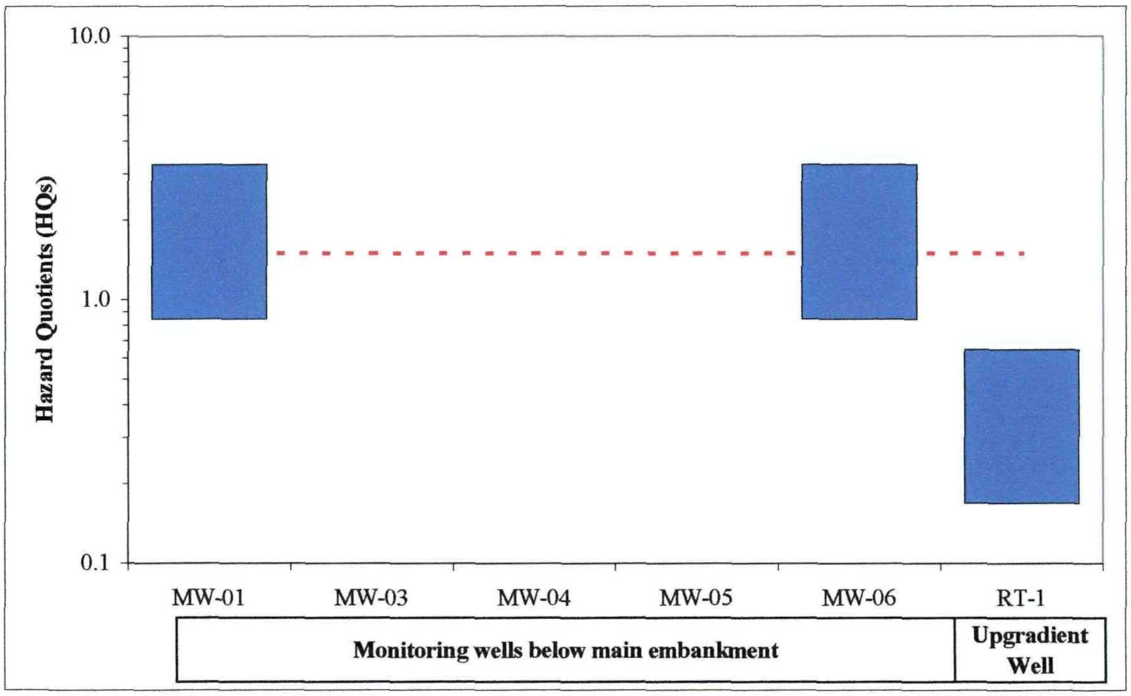
Figure 7-6
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Seeps*

Richardson Flats Tailings Site
Screening Ecological Risk Assessment

TOTAL SELENIUM



DISSOLVED SELENIUM



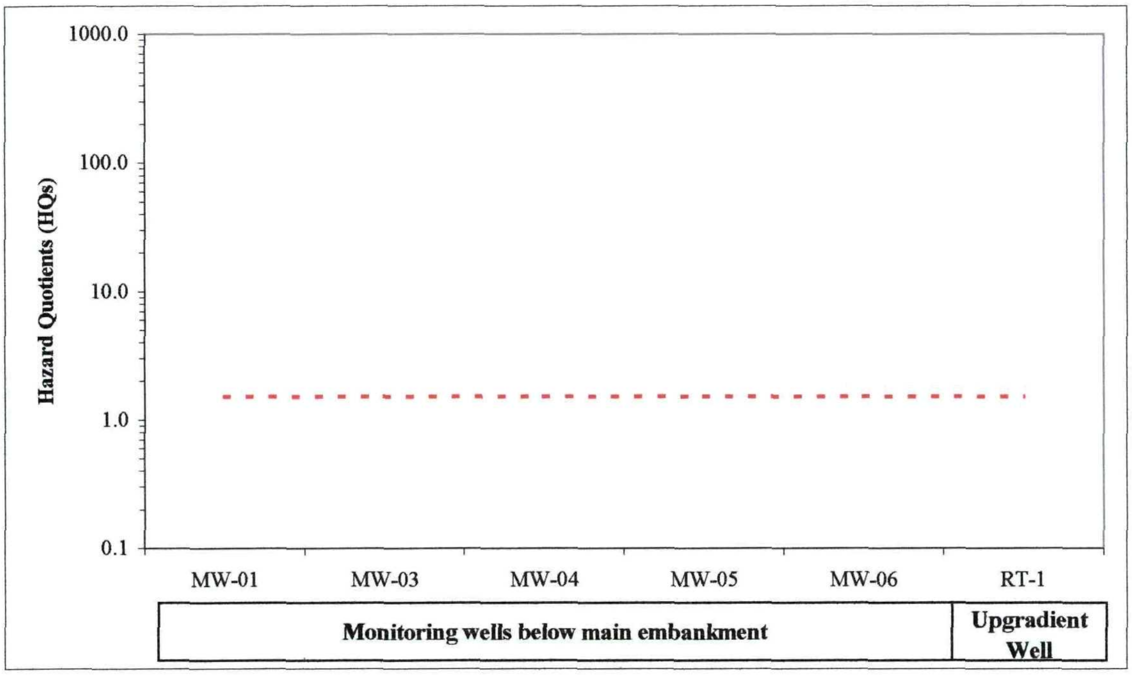
HQ ranges are based on the acute and chronic AWQC.

***Seep concentrations are estimated using available groundwater data.**

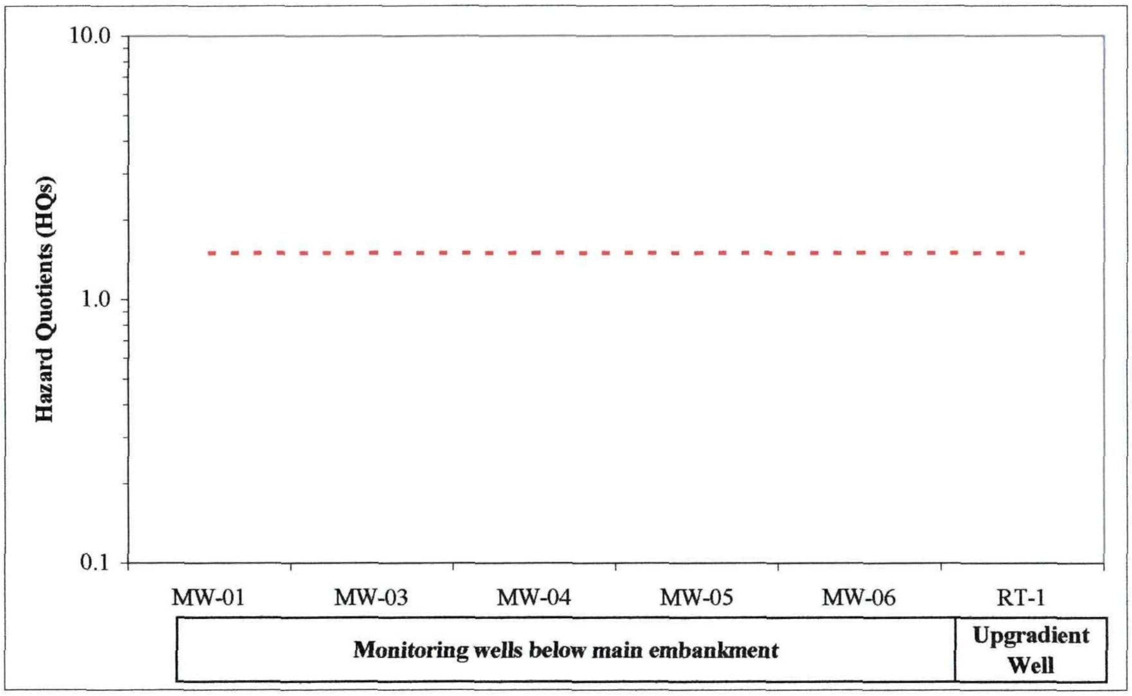
Figure 7-6
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Seeps*

Richardson Flats Tailings Site
Screening Ecological Risk Assessment

TOTAL SILVER



DISSOLVED SILVER

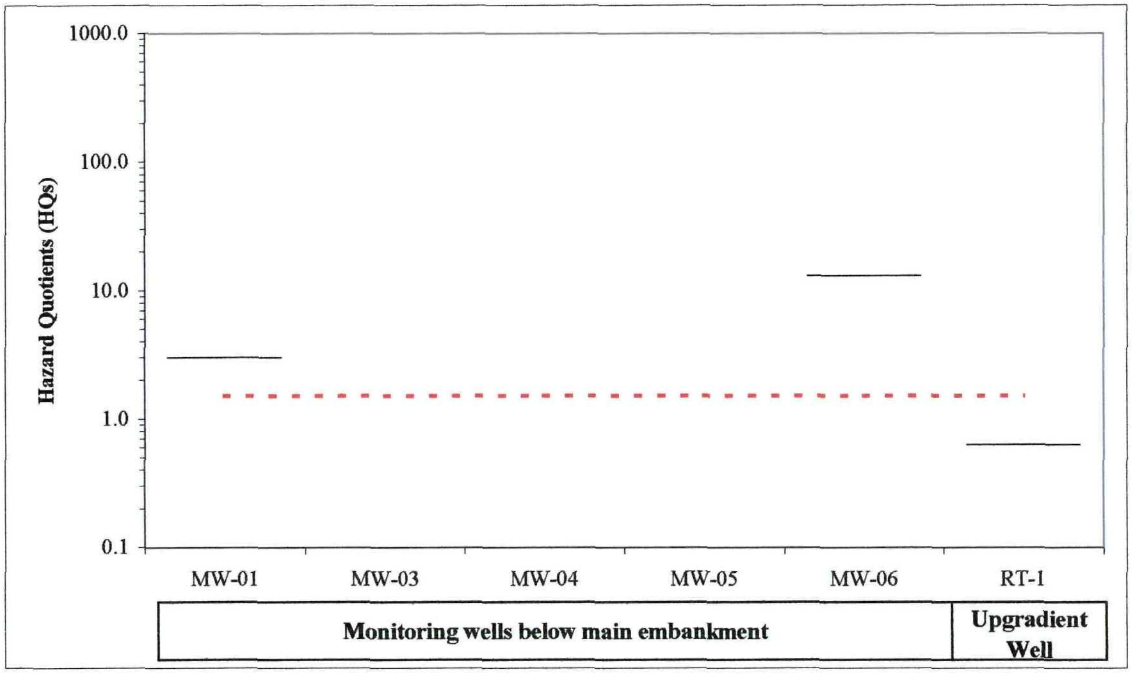


HQ ranges are based on the acute and chronic AWQC.
***Seep concentrations are estimated using available groundwater data.**

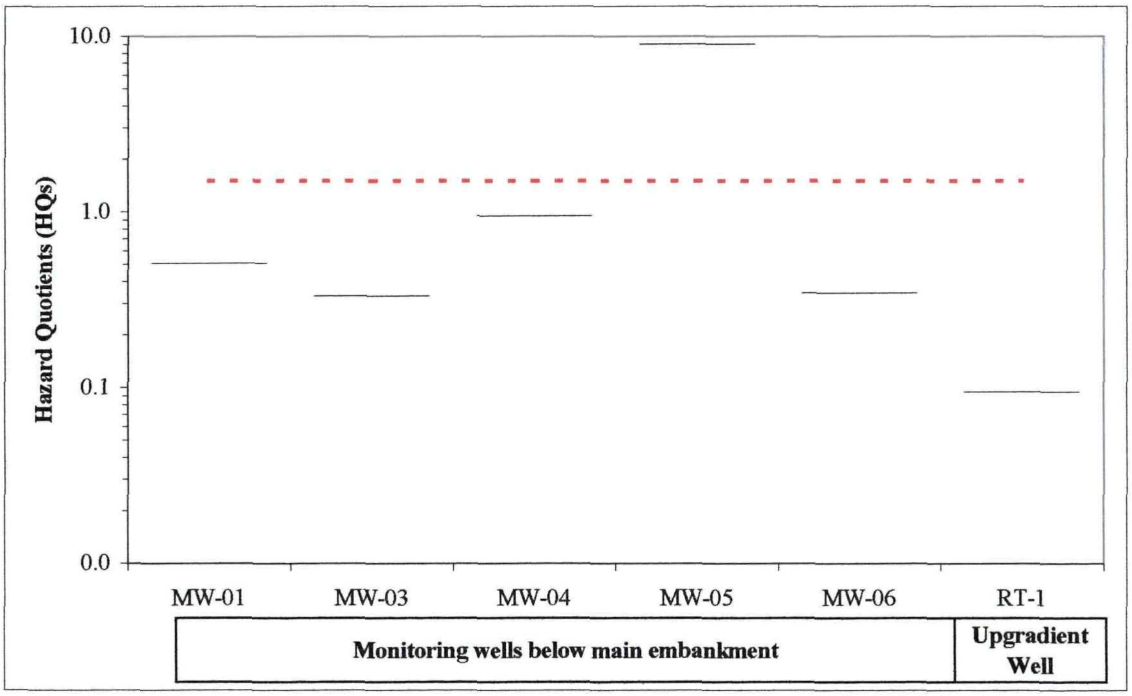
Figure 7-6
Hazard Quotients (HQs) for Aquatic Receptors from Direct Contact with Seeps*

Richardson Flats Tailings Site
Screening Ecological Risk Assessment

TOTAL ZINC



DISSOLVED ZINC

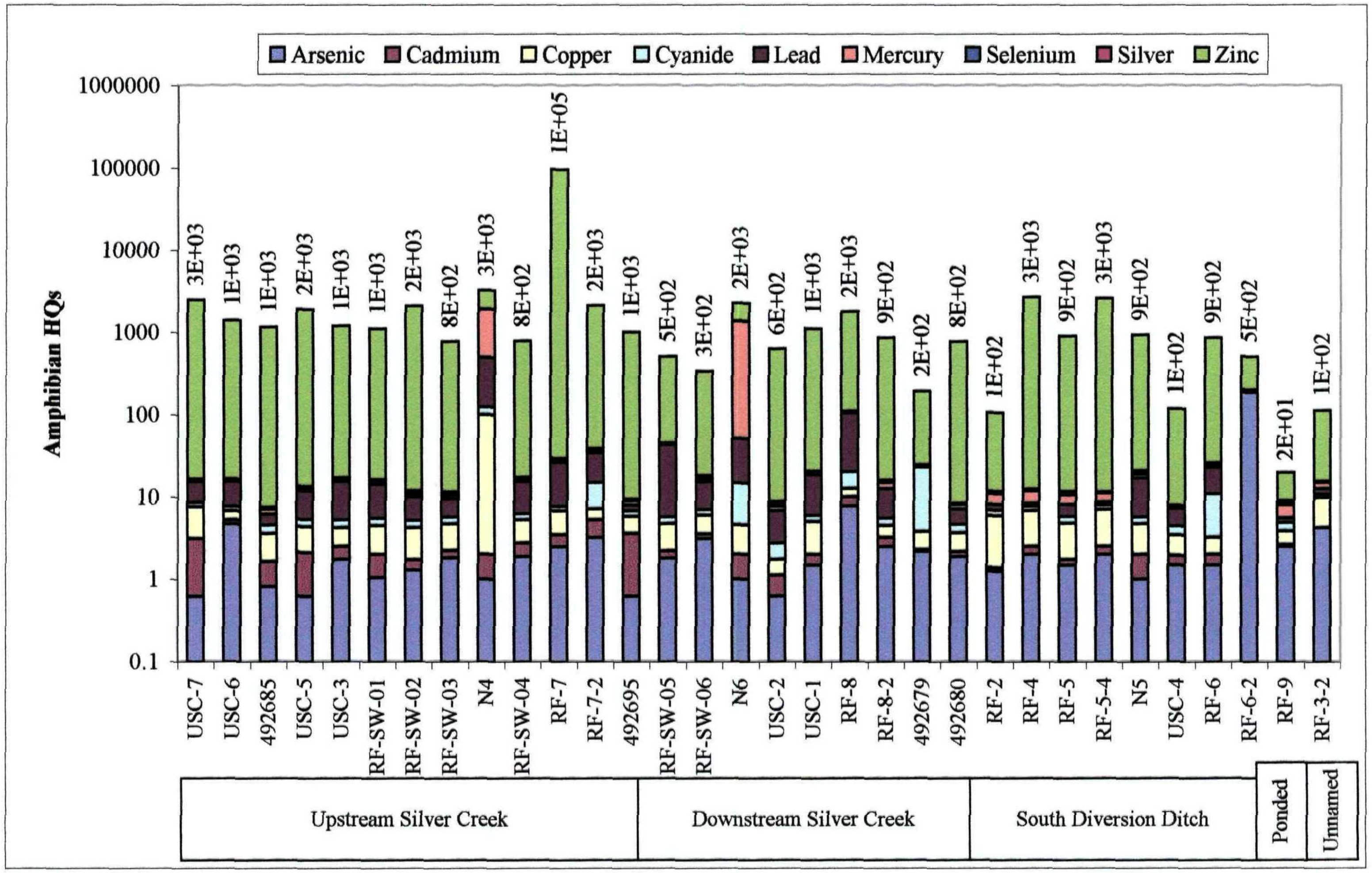


HQ ranges are based on the acute and chronic AWQC.
***Seep concentrations are estimated using available groundwater data.**

DRAFT

Figure 7-7
Contribution of COPC HQs from Direct Contact with Surface Water to the Total HI for Amphibians

Screening Ecological Risk Assessment for Richardson Flats Tailings

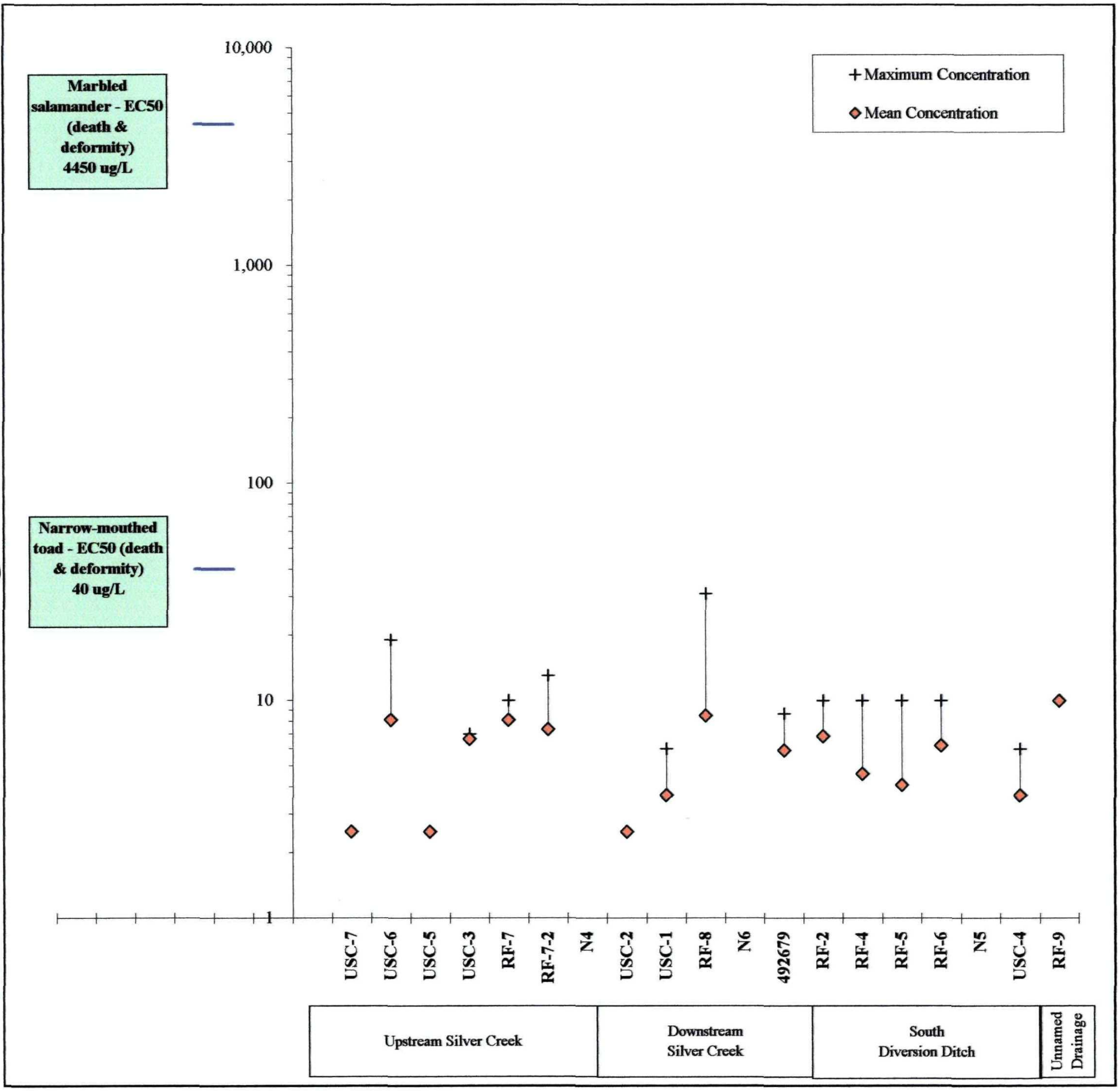


Amphibian_SW EPC by station.xls: Graphs
2/10/2002

Figure 7-8a

Comparison of Total Arsenic Concentrations with Species Toxicity Values for Amphibians

Screening Level Ecological Risk Assessment for Richardson Flat Tailings Site



Concentrations and TRVs are in units of ug/L

All toxicity values calculated at hardness = 100mg/L

All concentration values normalized to hardness = 100mg/L

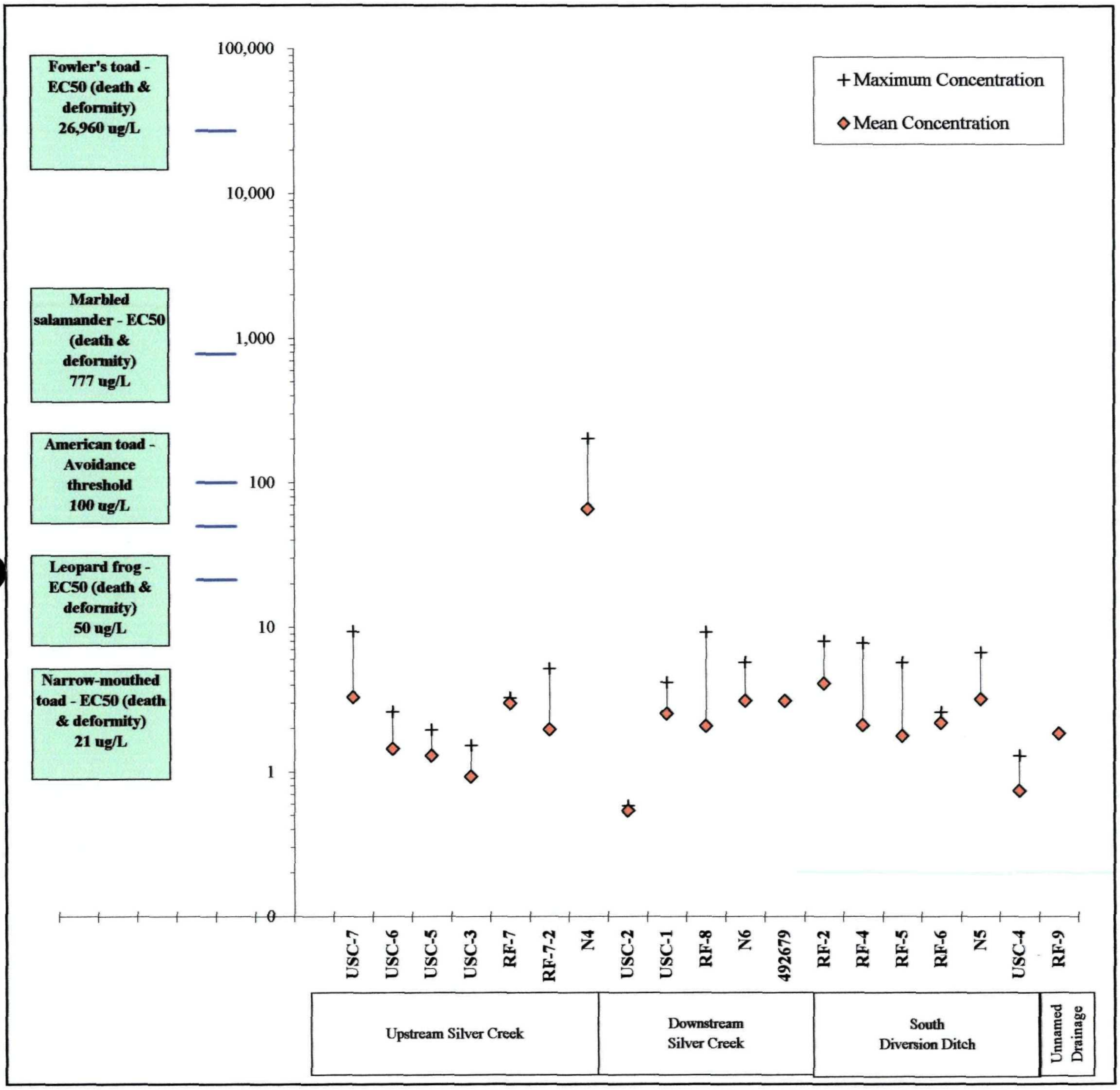
If station-specific hardness measurements were not available, a site hardness of 200 mg/L was assumed.

DRAFT

Figure 7-8b

Comparison of Total Copper Concentrations with Species Toxicity Values for Amphibians

Screening Level Ecological Risk Assessment for Richardson Flat Tailings Site



Concentrations and TRVs are in units of ug/L

All toxicity values calculated at hardness = 100mg/L

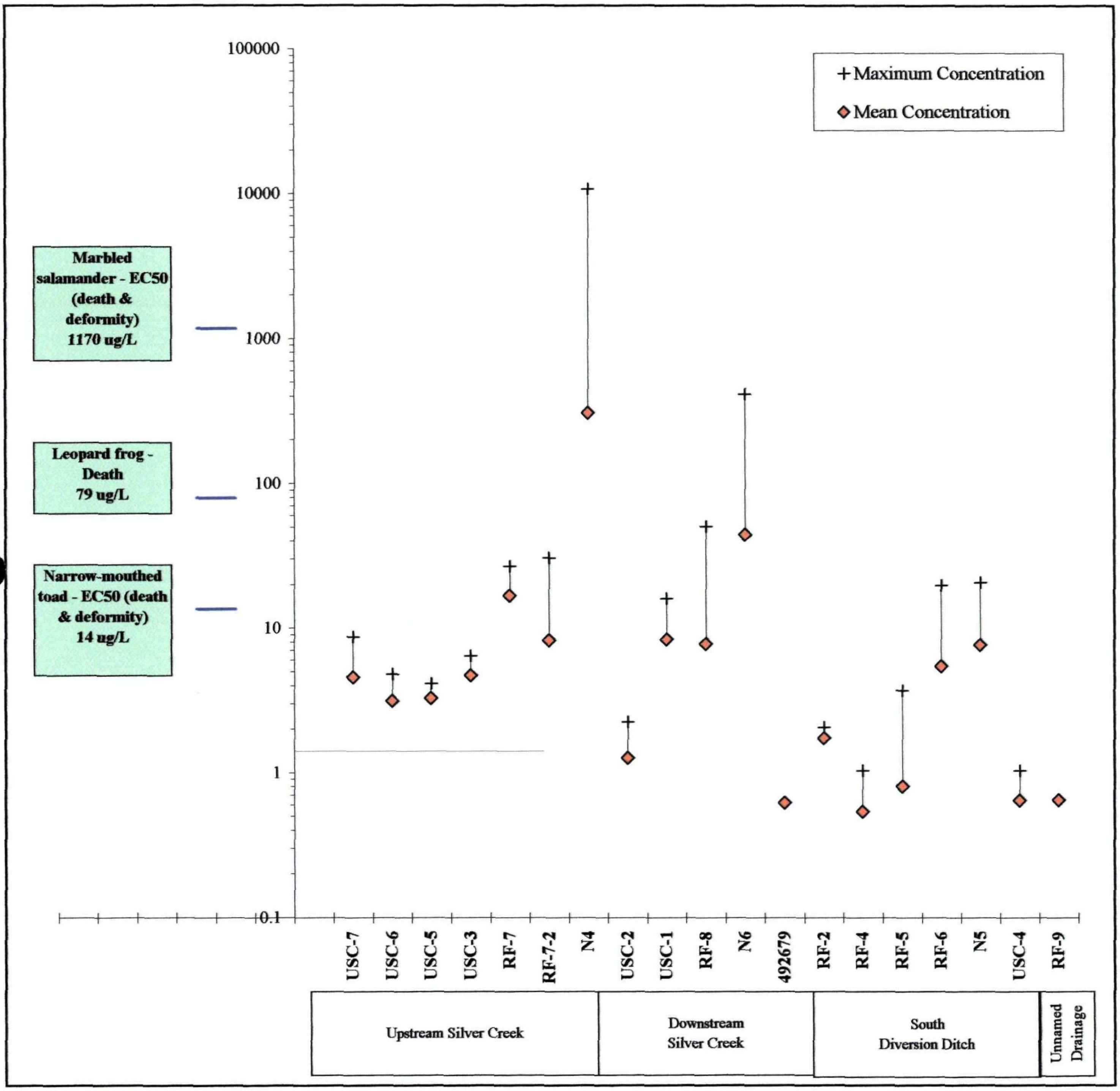
All concentration values normalized to hardness = 100mg/L

If station-specific hardness measurements were not available, a site hardness of 200 mg/L was assumed.

Figure 7-8c

Comparison of Total Lead Concentrations with Species Toxicity Values for Amphibians

Screening Level Ecological Risk Assessment for Richardson Flat Tailings Site



Concentrations and TRVs are in units of ug/L

All toxicity values calculated at hardness = 100mg/L

All concentration values normalized to hardness = 100mg/L

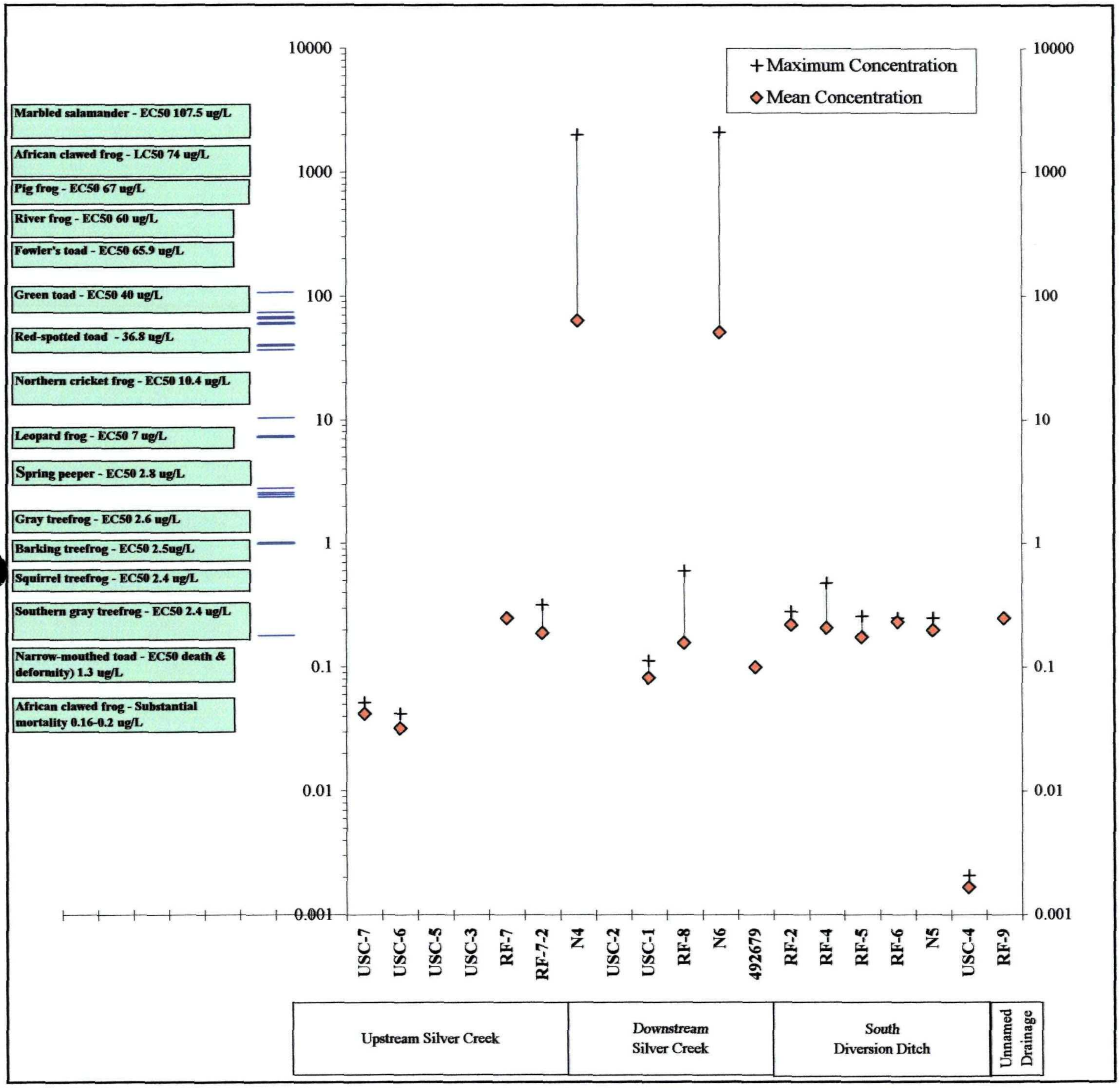
If station-specific hardness measurements were not available, a site hardness of 200 mg/L was assumed.

DRAFT

Figure 7-8d

Comparison of Total Mercury Concentrations with Species Toxicity Values for Amphibians

Screening Level Ecological Risk Assessment for Richardson Flat Tailings Site



Concentrations and TRVs are in units of ug/L

All toxicity values calculated at hardness = 100mg/L

All concentration values normalized to hardness = 100mg/L

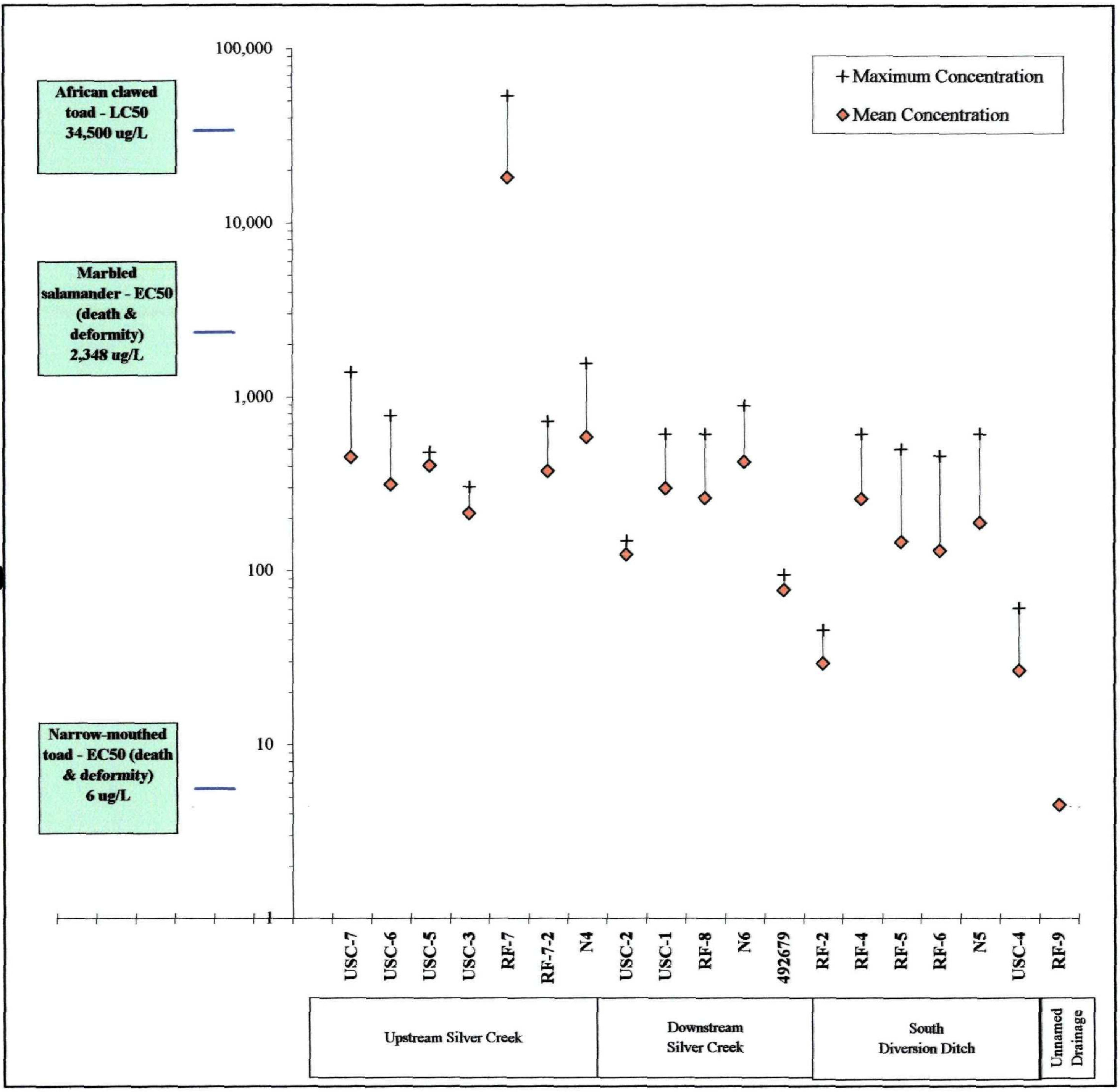
If station-specific hardness measurements were not available, a site hardness of 200 mg/L was assumed.

Amphibian Thermometer Graphs rev.xls;Hg Adj Graph
2/10/2002

Figure 7-8e

Comparison of Total Zinc Concentrations with Species Toxicity Values for Amphibians

Screening Level Ecological Risk Assessment for Richardson Flat Tailings Site

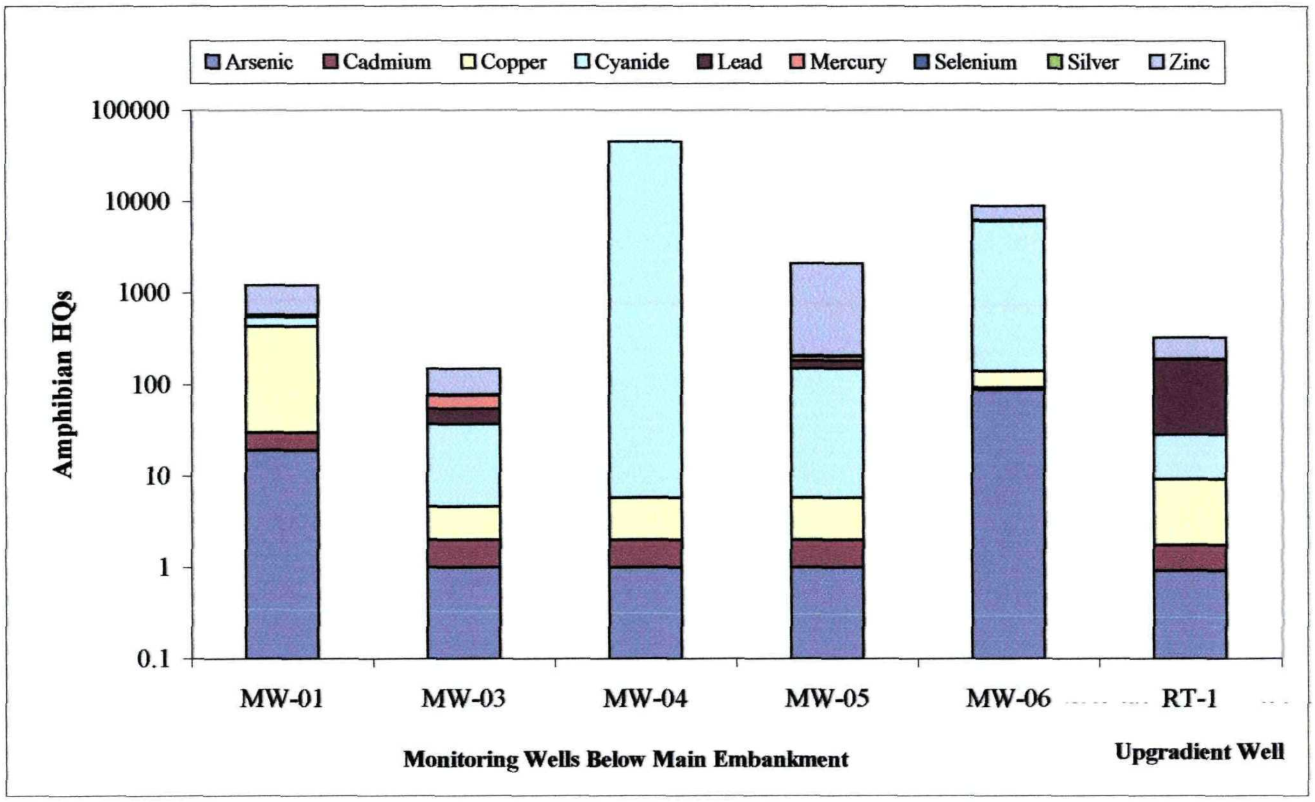


Concentrations and TRVs are in units of ug/L
All toxicity values calculated at hardness = 100mg/L
All concentration values normalized to hardness = 100mg/L
If station-specific hardness measurements were not available, a site hardness of 200 mg/L was assumed.

Amphibian Thermometer Graphs rev.xls;Zn Adj Graph
2/10/2002

Figure 7-9
Contribution of COPC HQs from Direct Contact with Seeps* to the Total HI for Amphibians

Screening Ecological Risk Assessment for The Richardson Flats Tailings Site

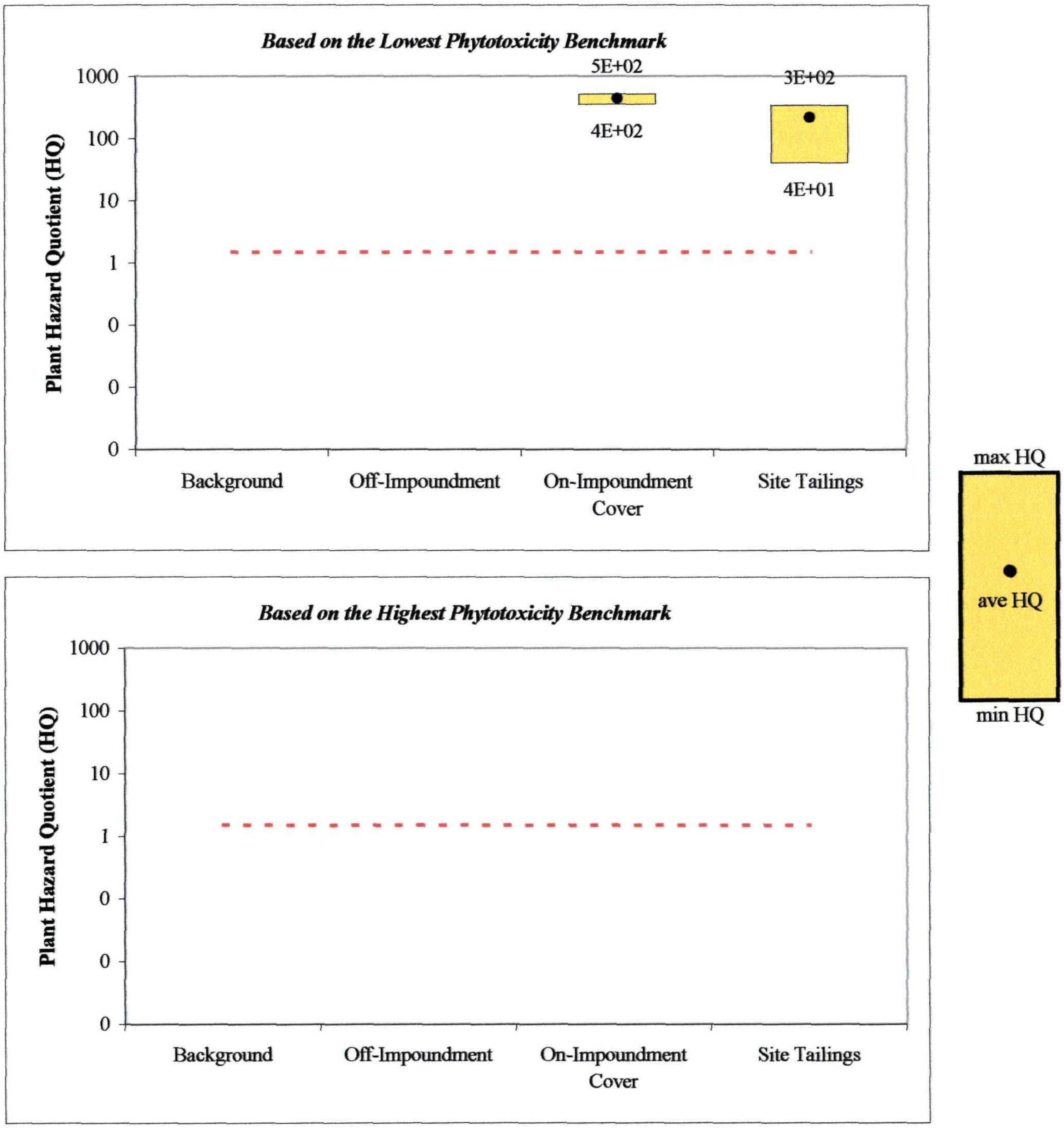


*** Seep concentrations are estimated using available groundwater data.**

Figure 7-10
Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Aluminum

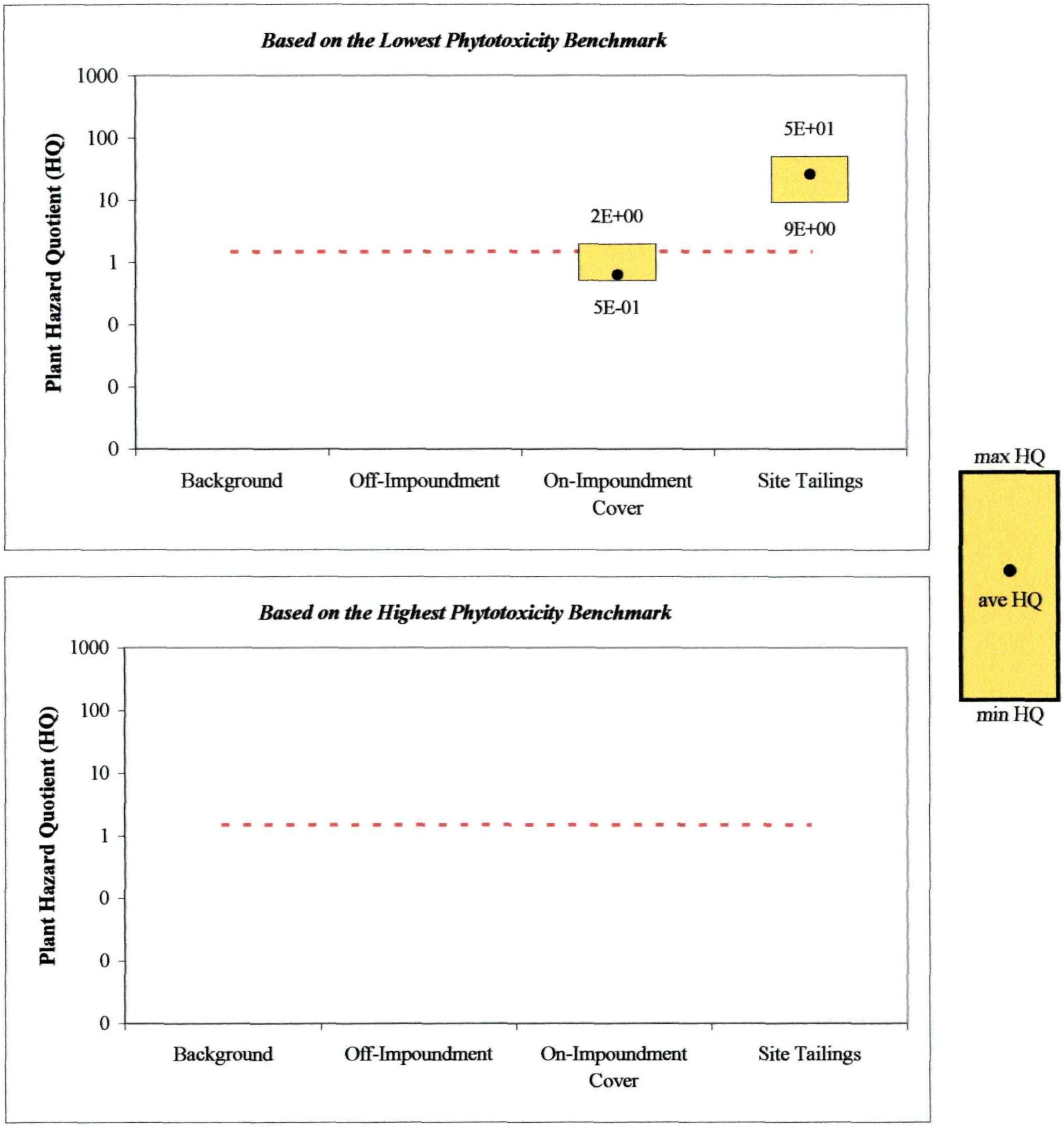


Plant Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

Figure 7-10
Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Antimony

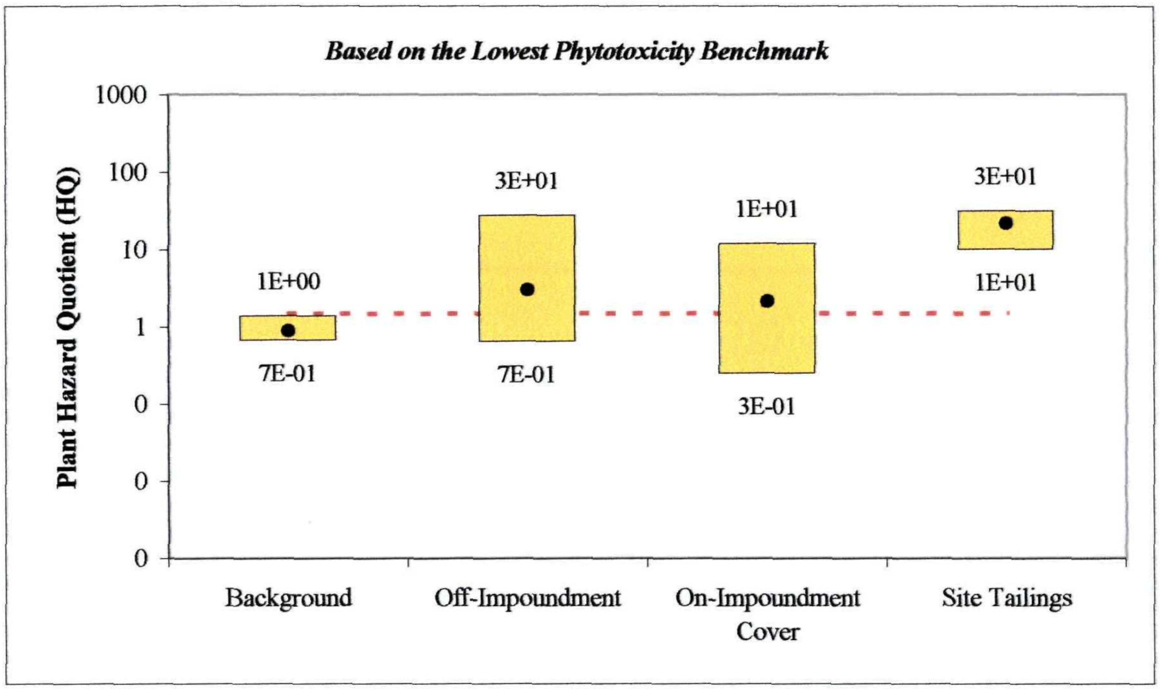


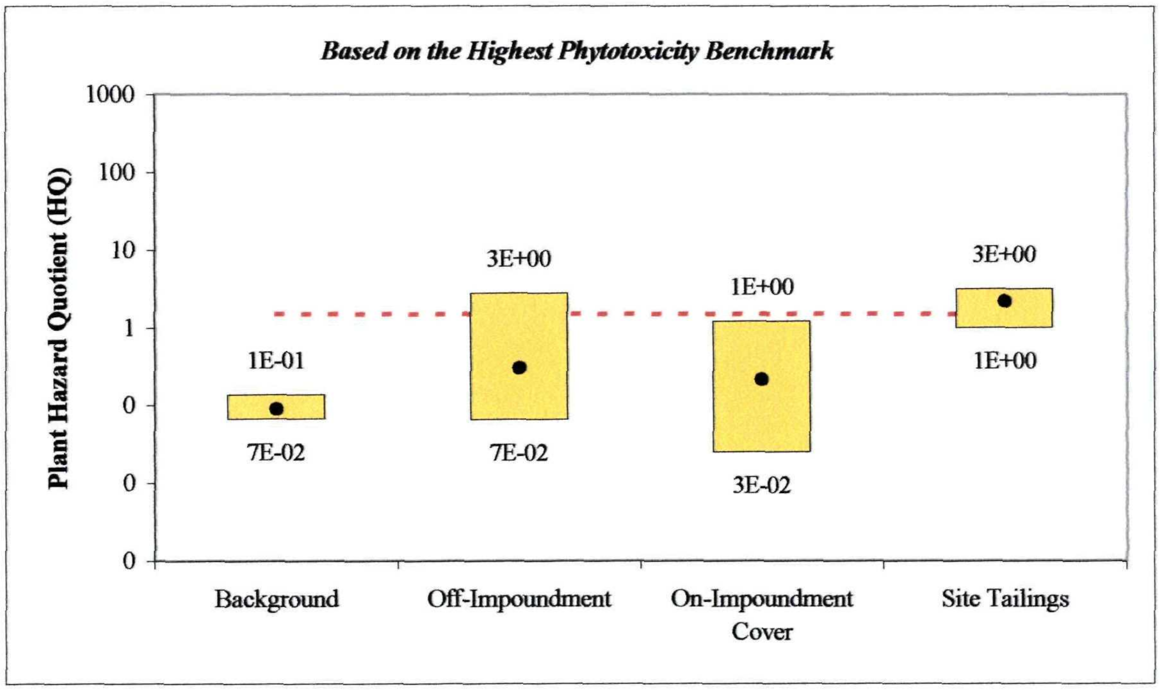
Plant Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

Figure 7-10
Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Arsenic



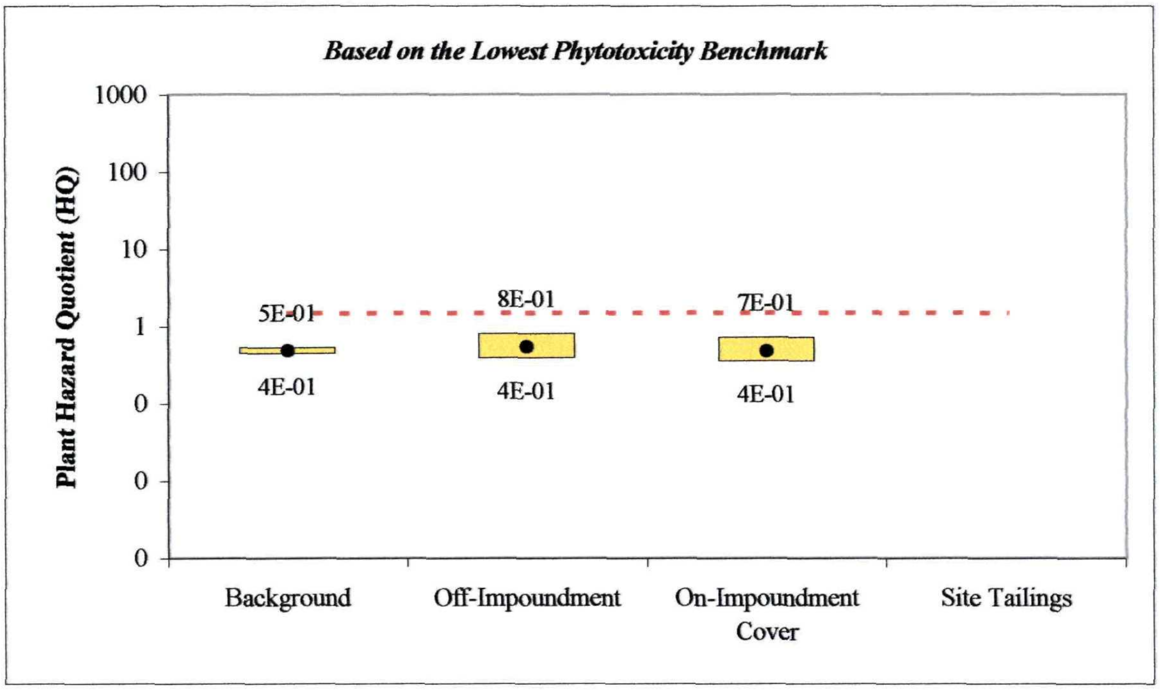


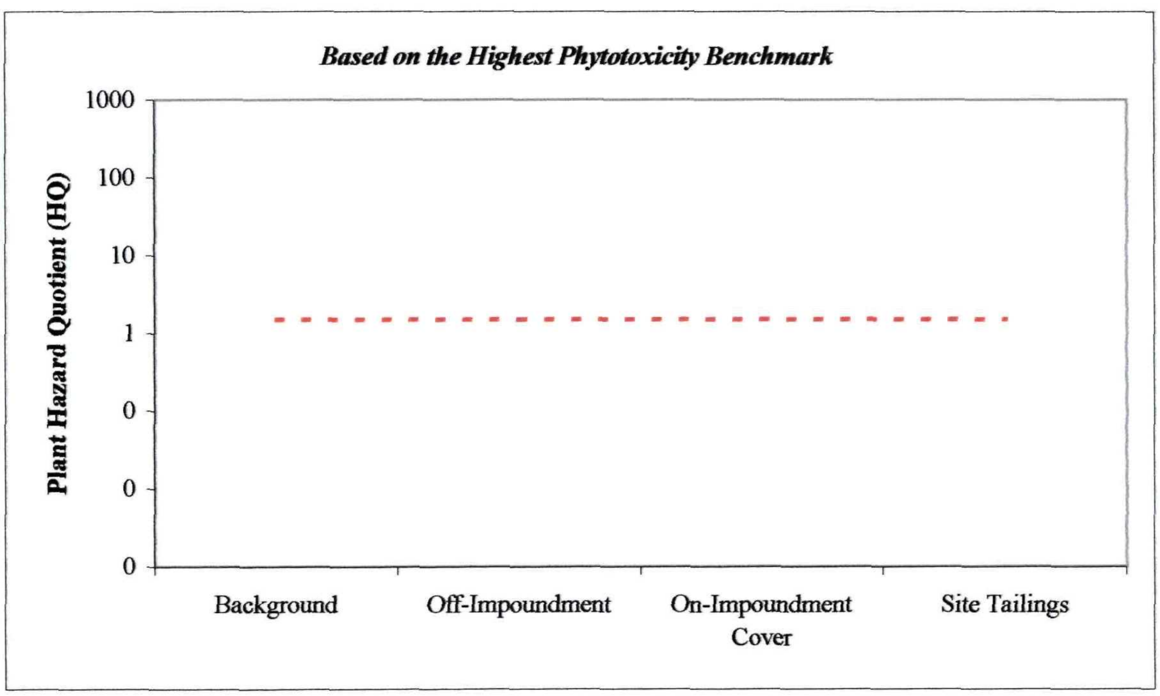
Plant Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

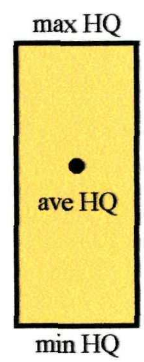
Figure 7-10
Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Barium





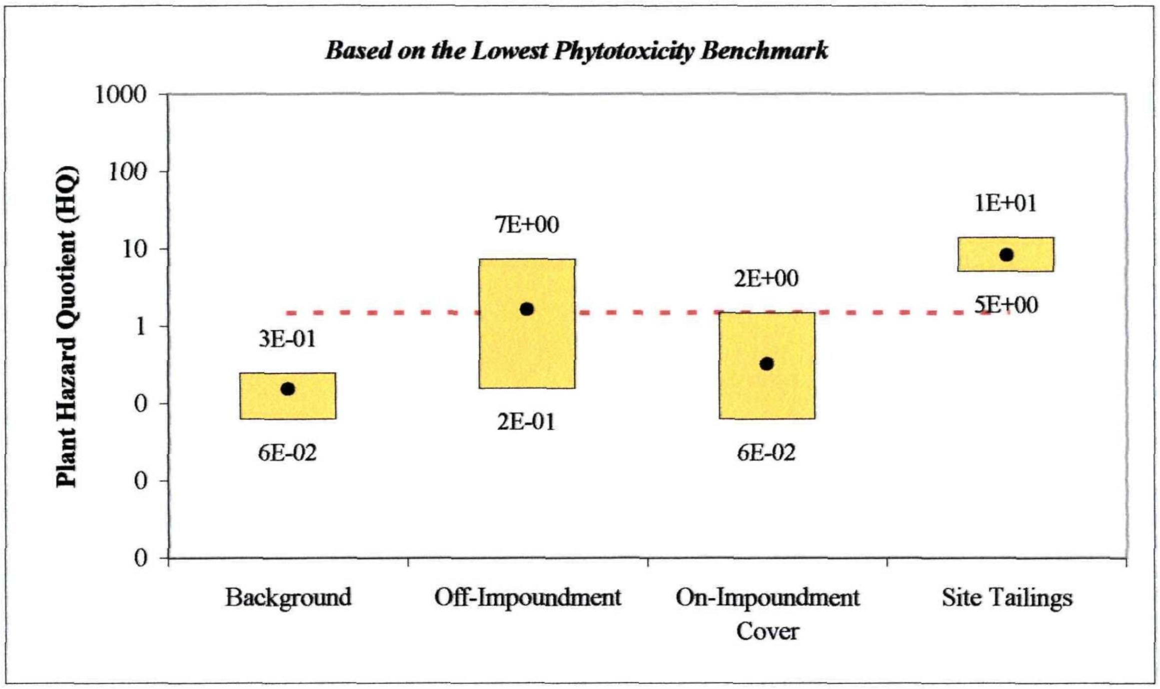


Plant Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

Figure 7-10
Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Cadmium



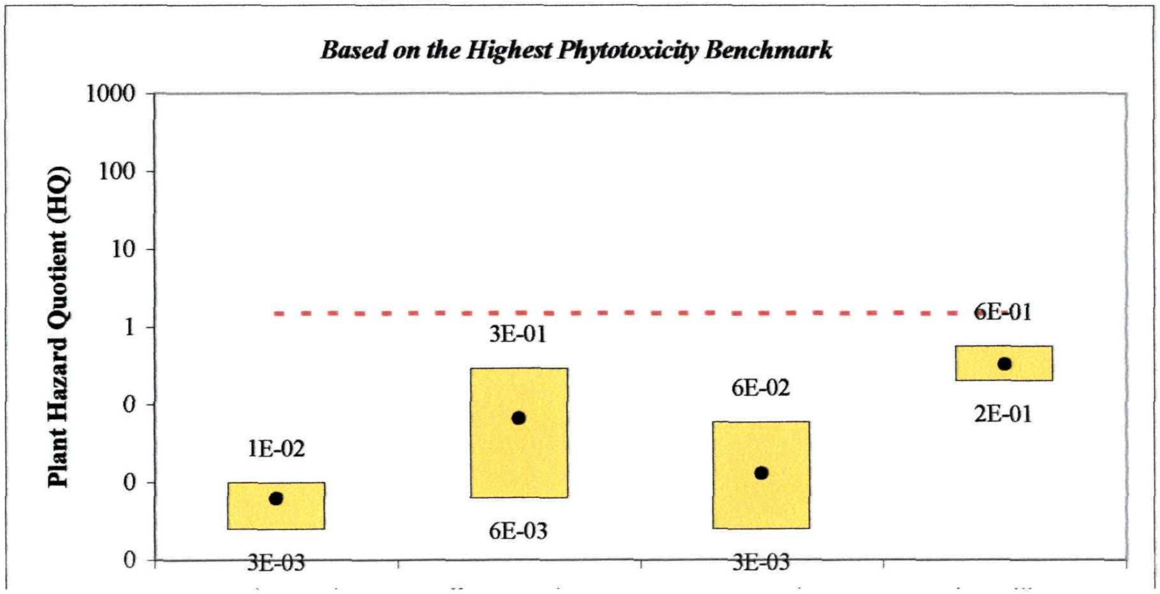
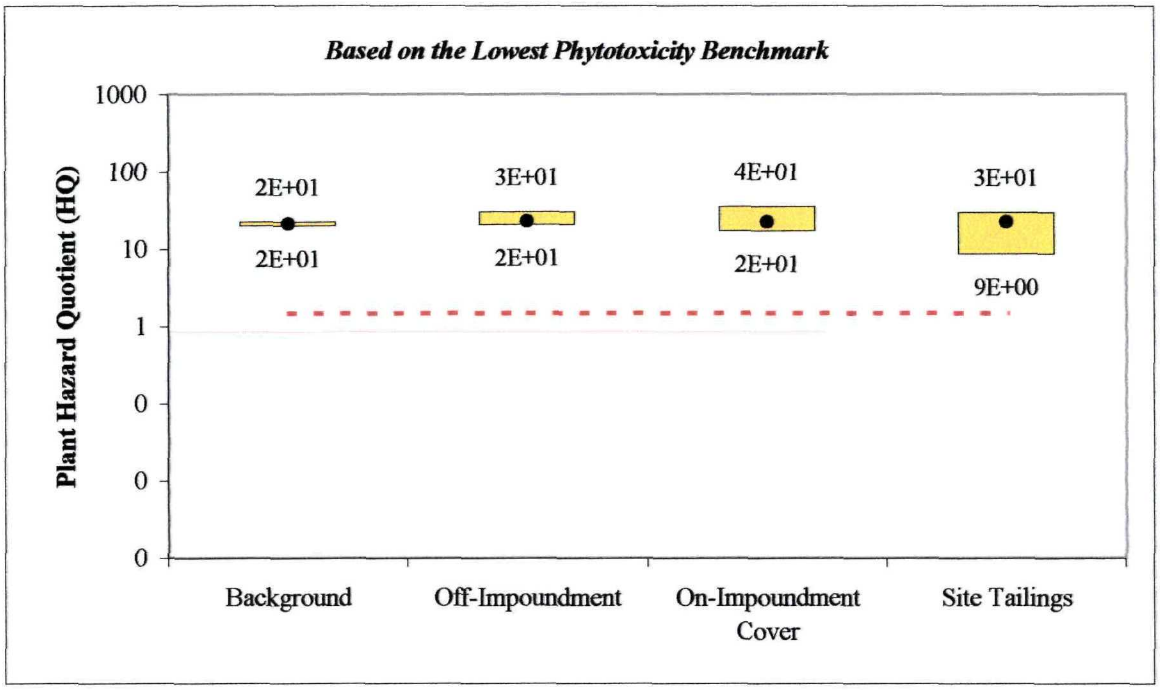
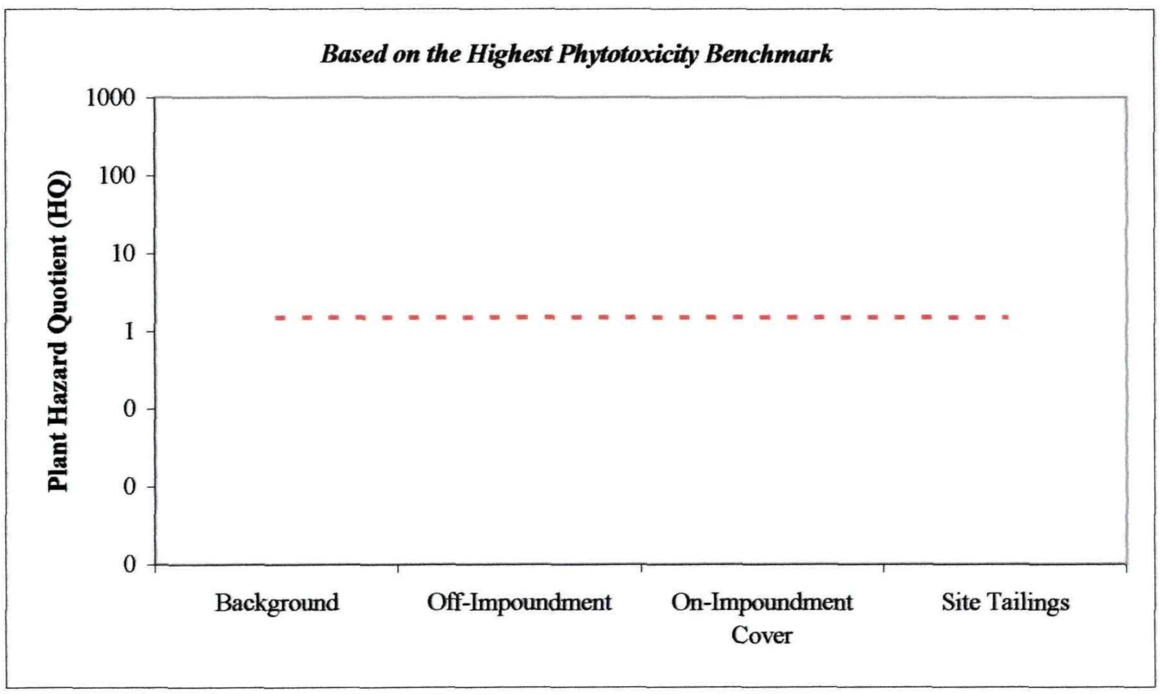


Figure 7-10
Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Chromium



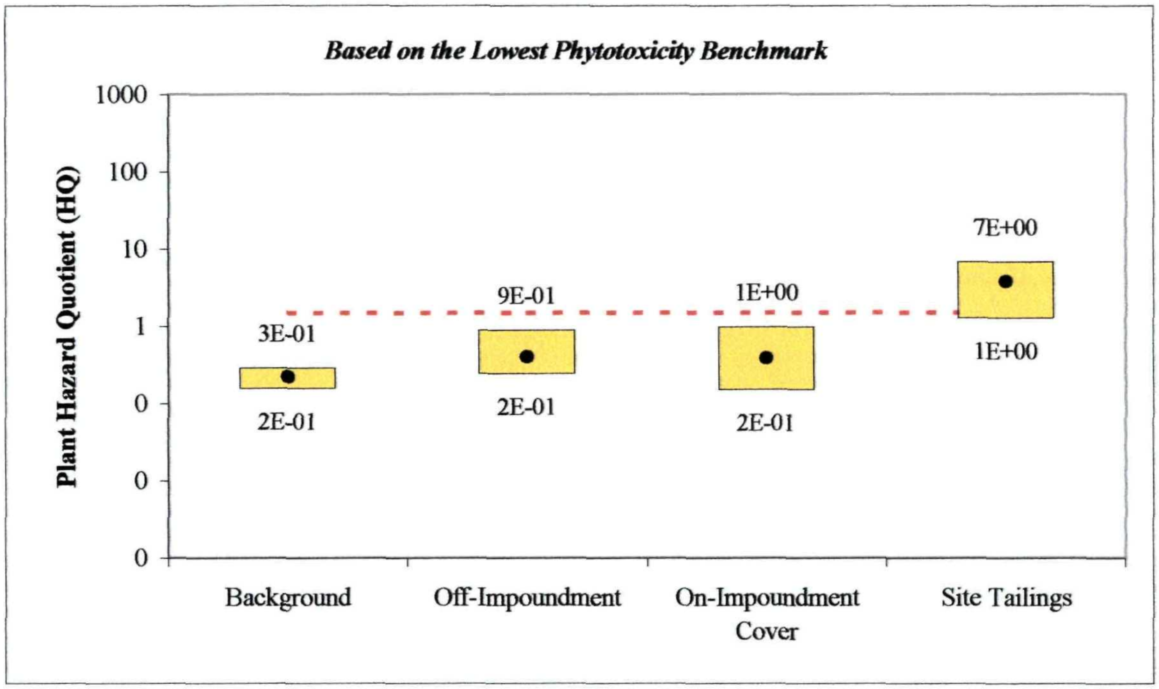


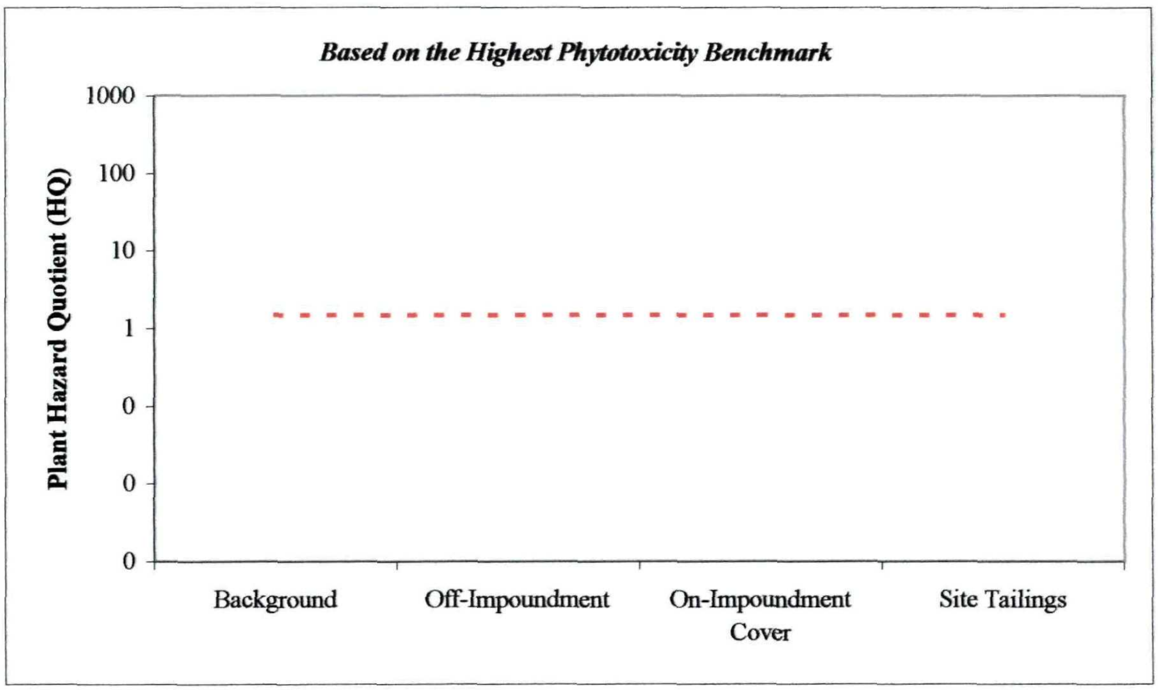
Plant Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

Figure 7-10
Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Copper



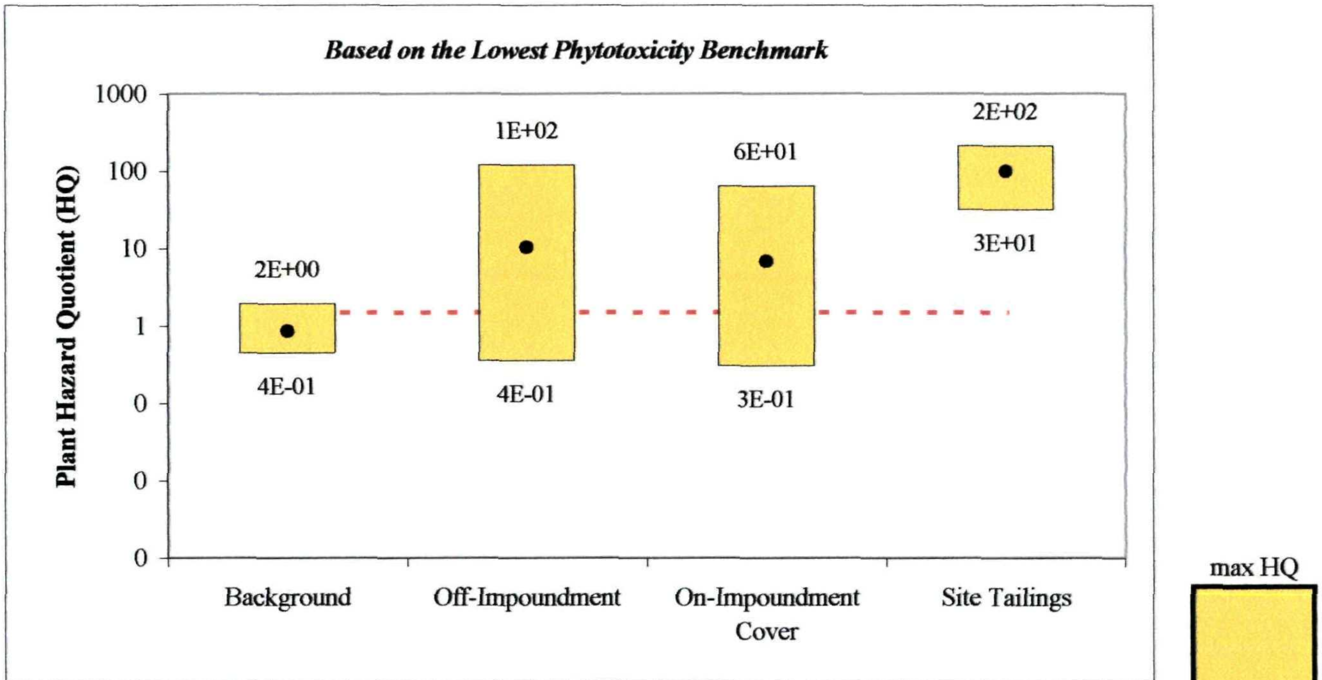


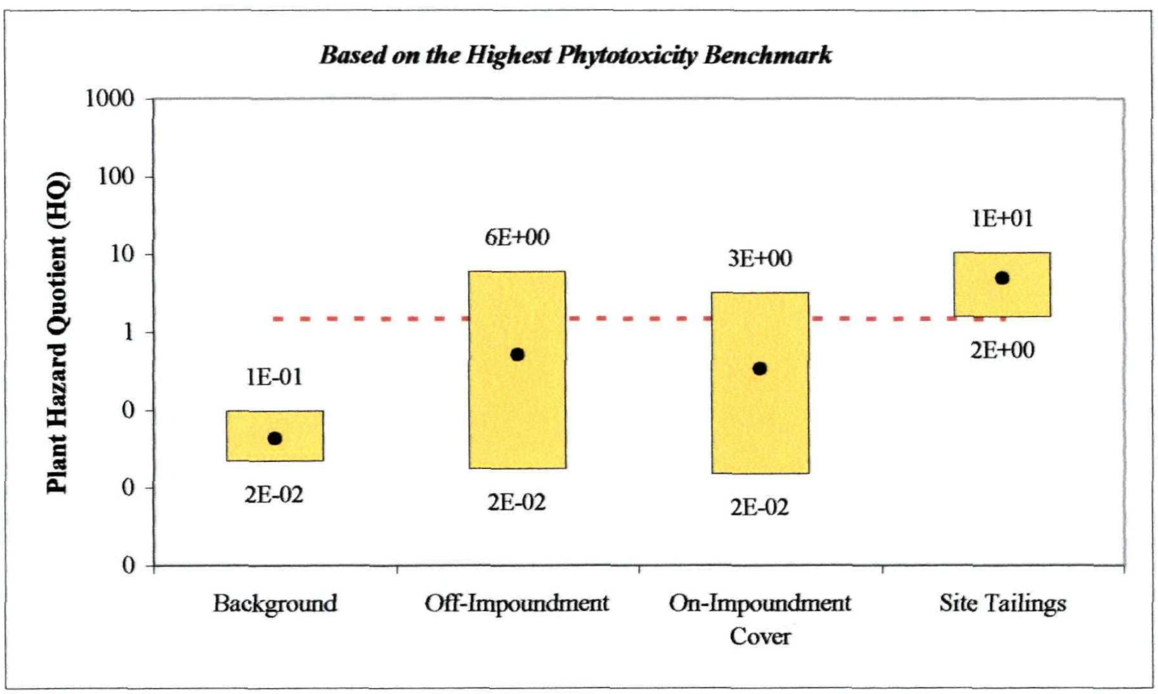
Plant Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

Figure 7-10
Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Lead



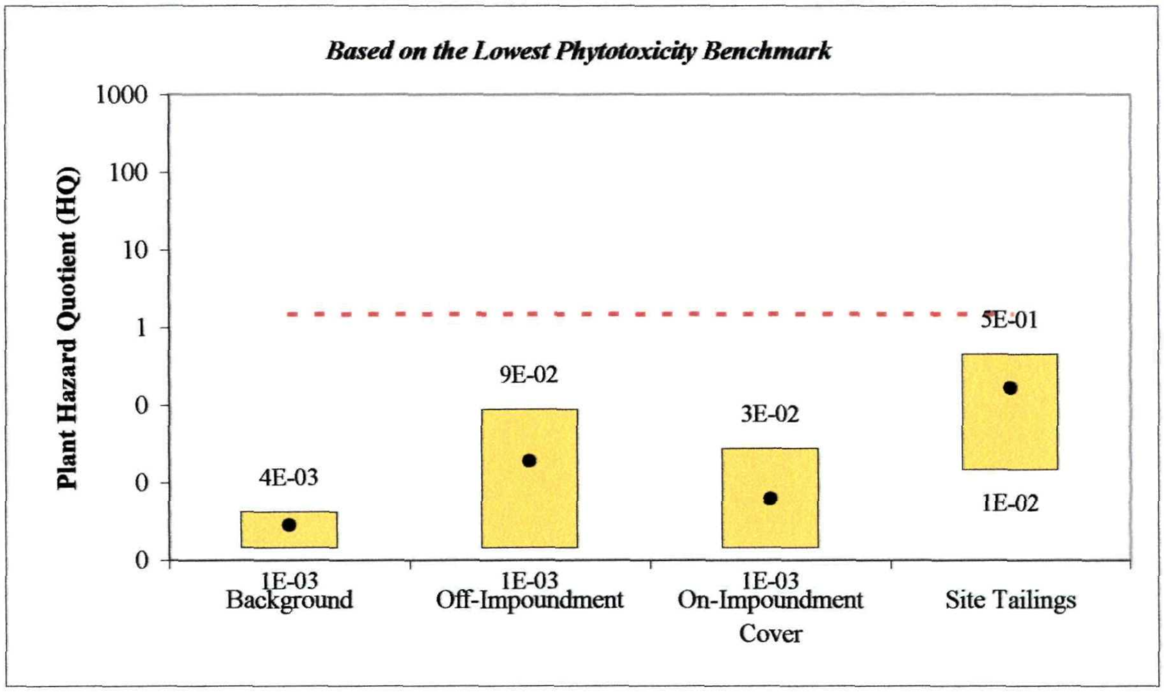


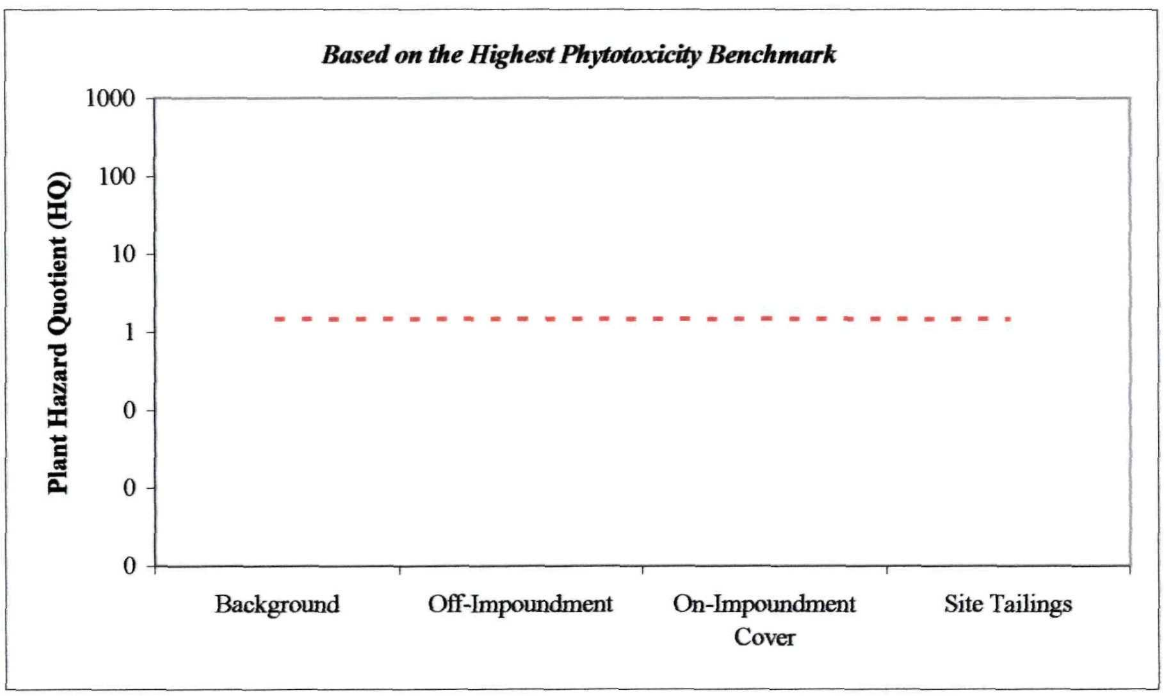
Plant Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

Figure 7-10
Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Mercury



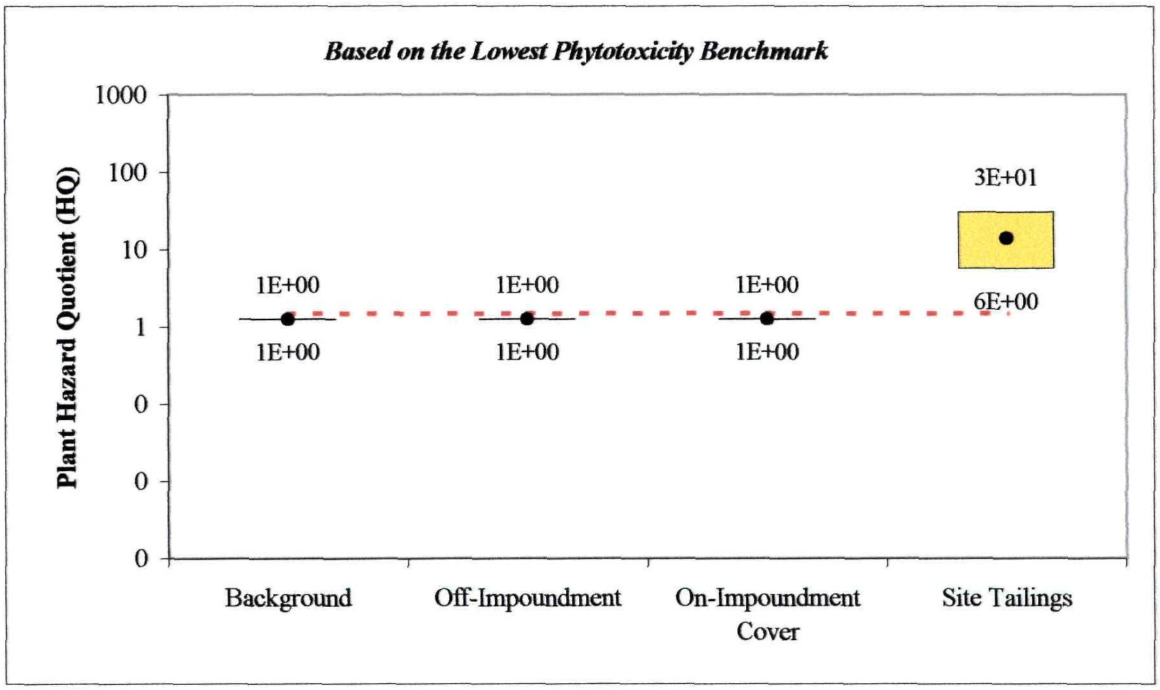


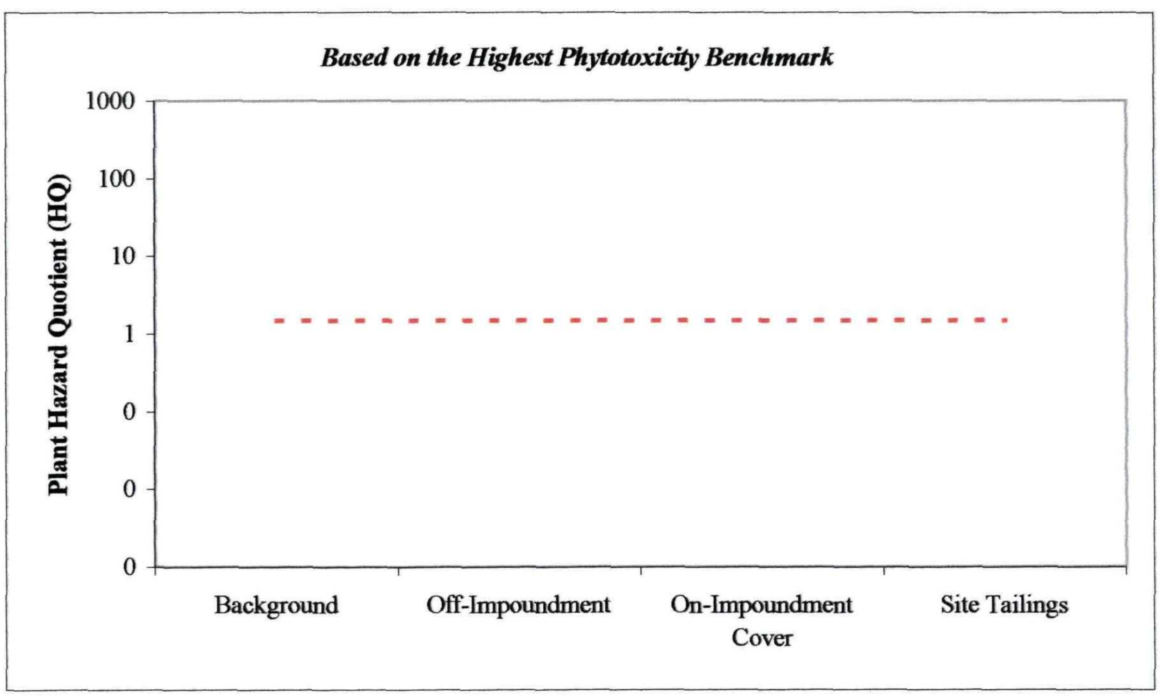
Plant Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

Figure 7-10
Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Silver



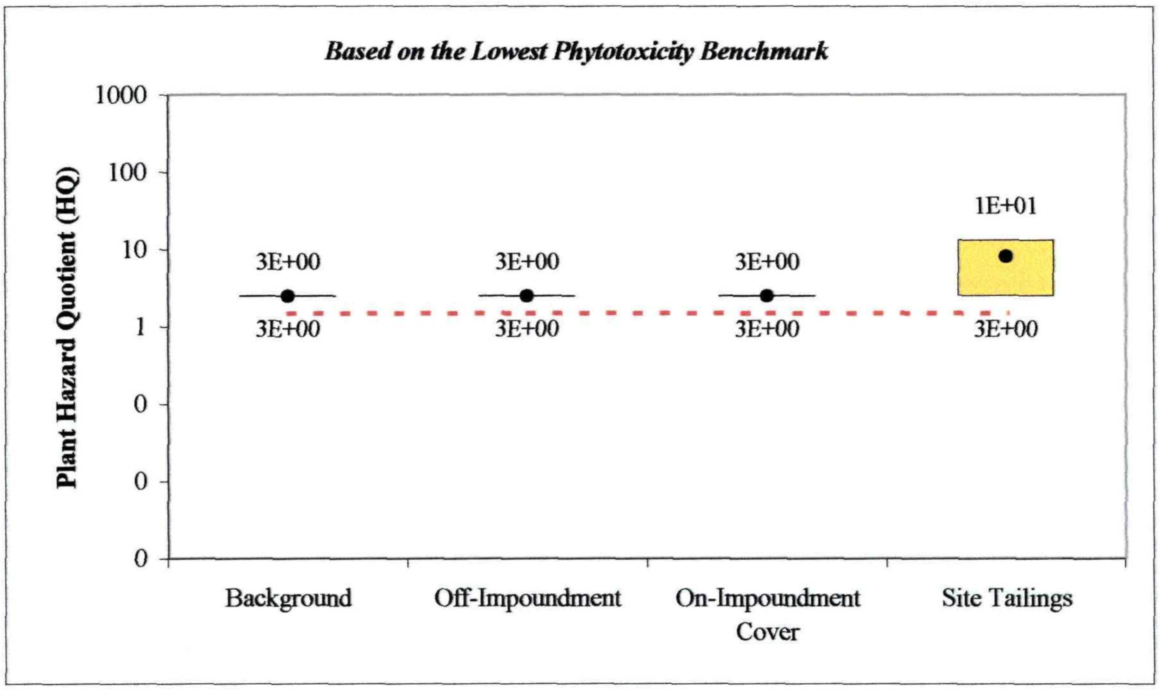


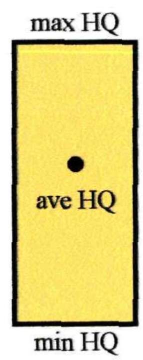
Plant Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

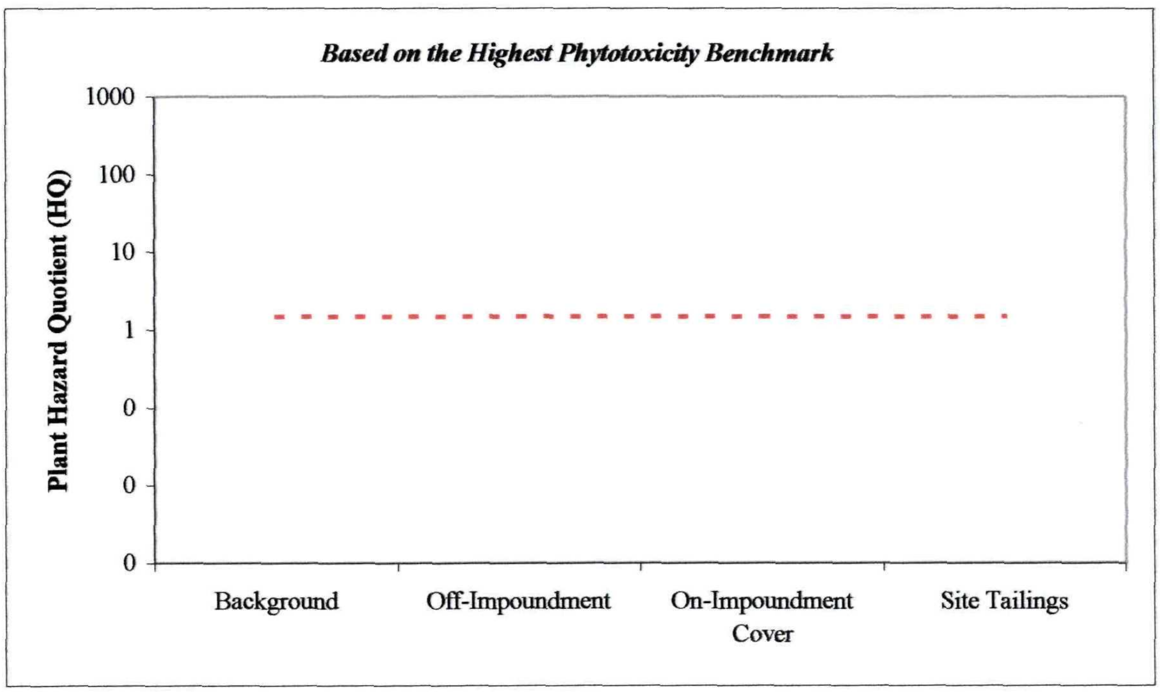
Figure 7-10
Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Selenium





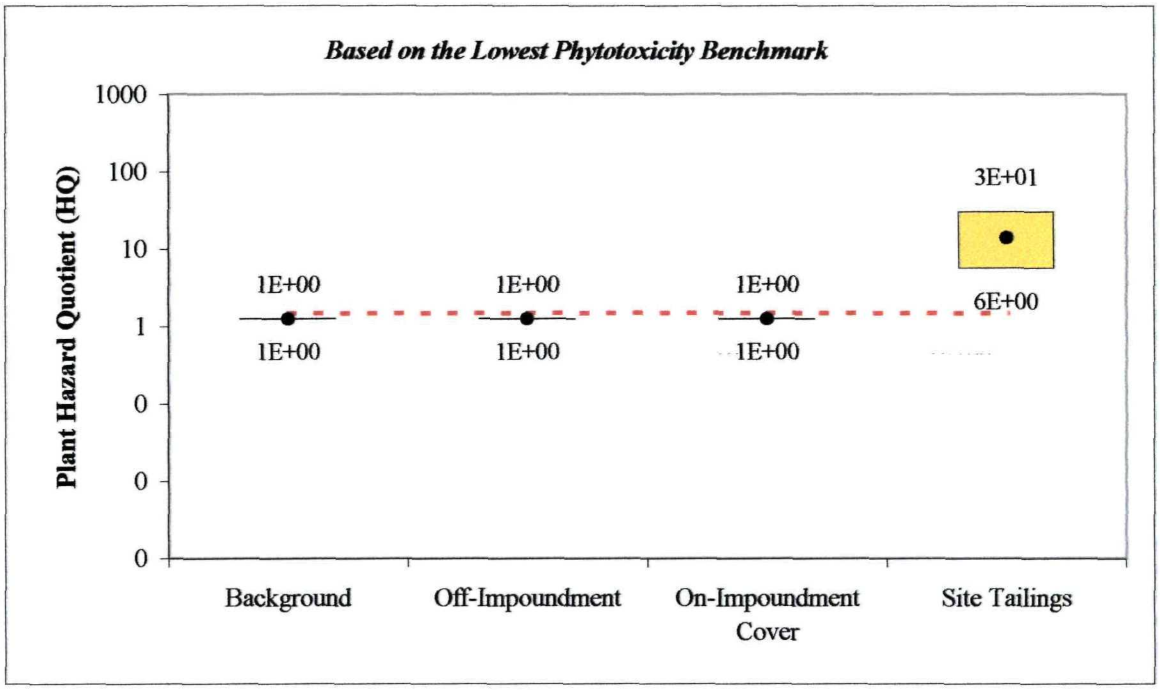


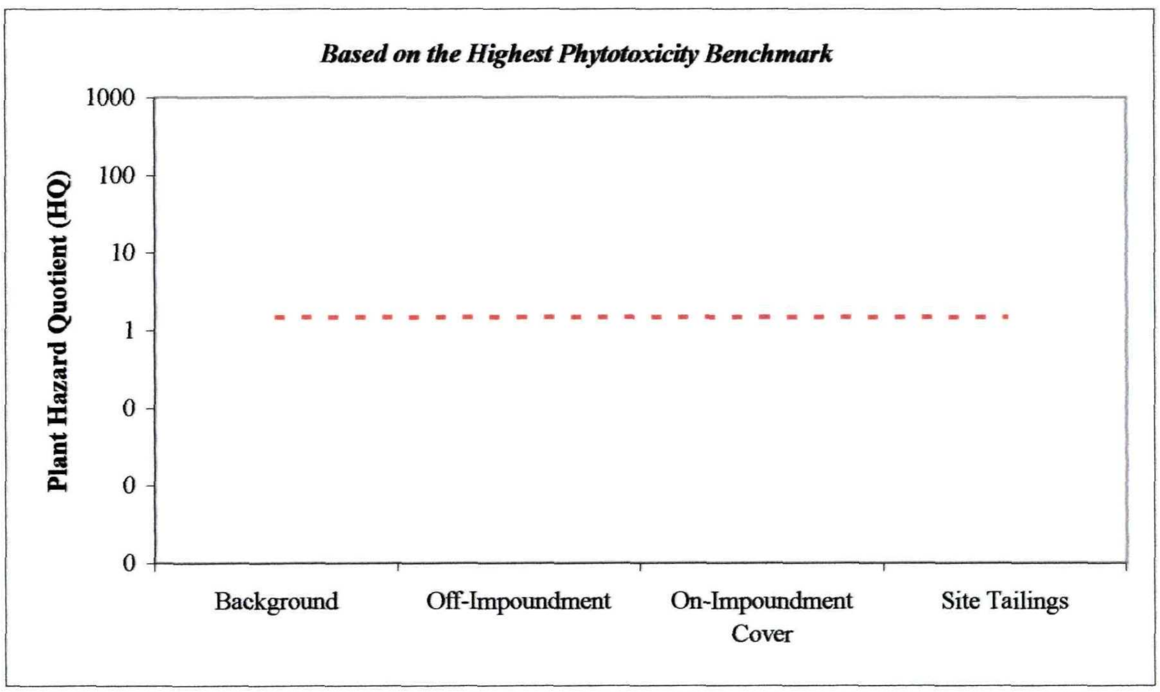
Plant Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

Figure 7-10
Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Silver



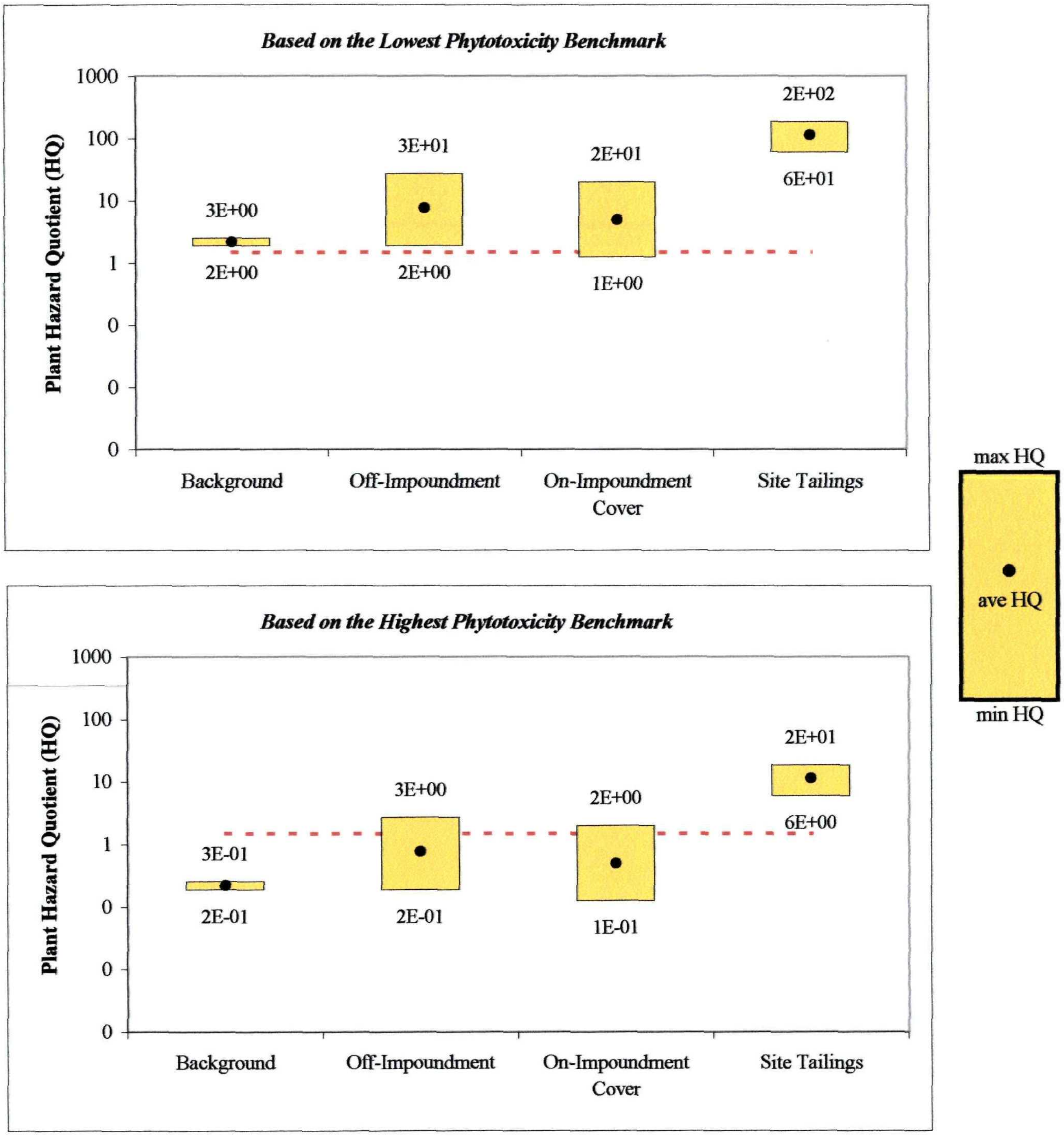


Plant Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

Figure 7-10
Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Zinc

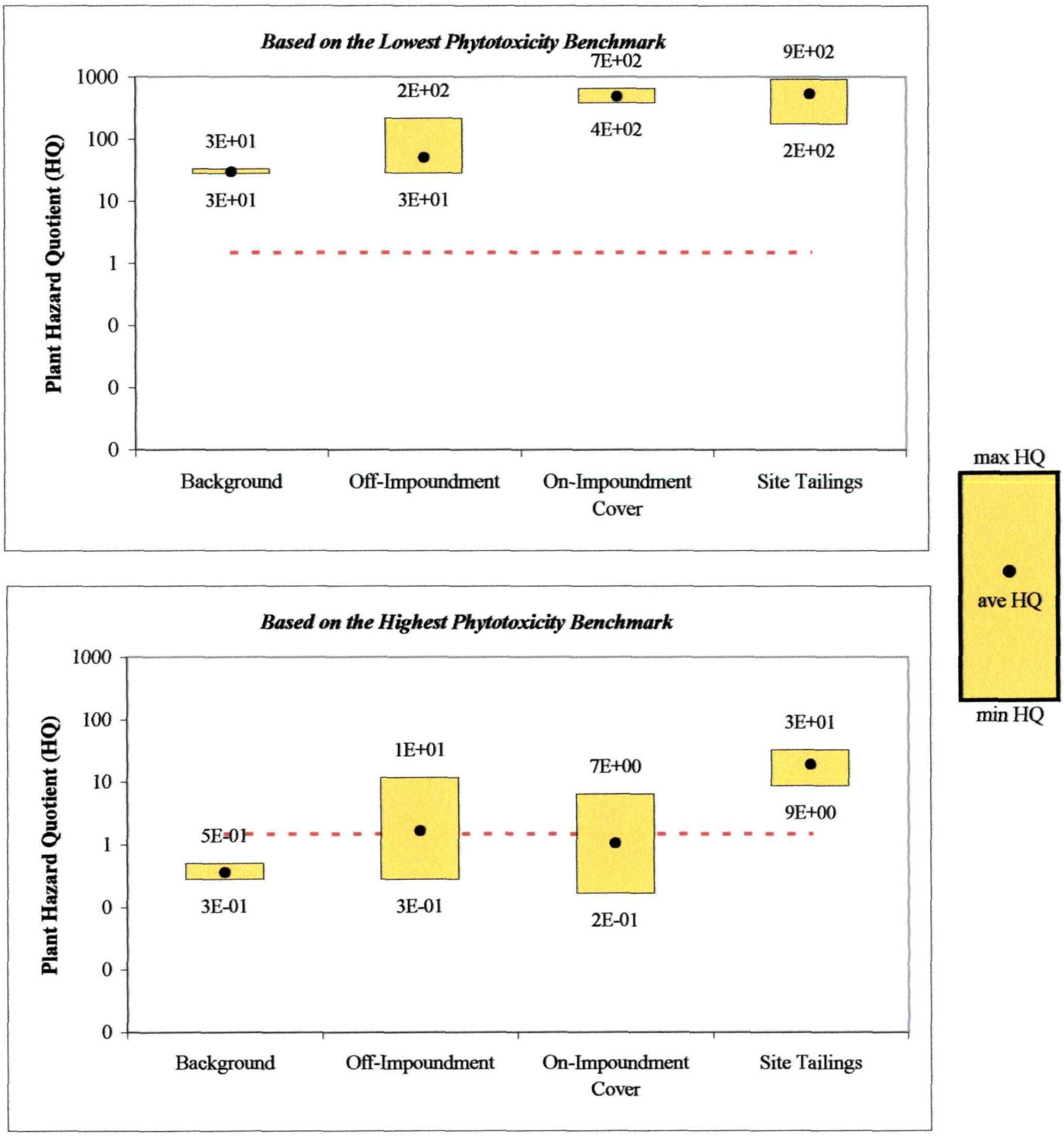


Plant Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

Figure 7-10
Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

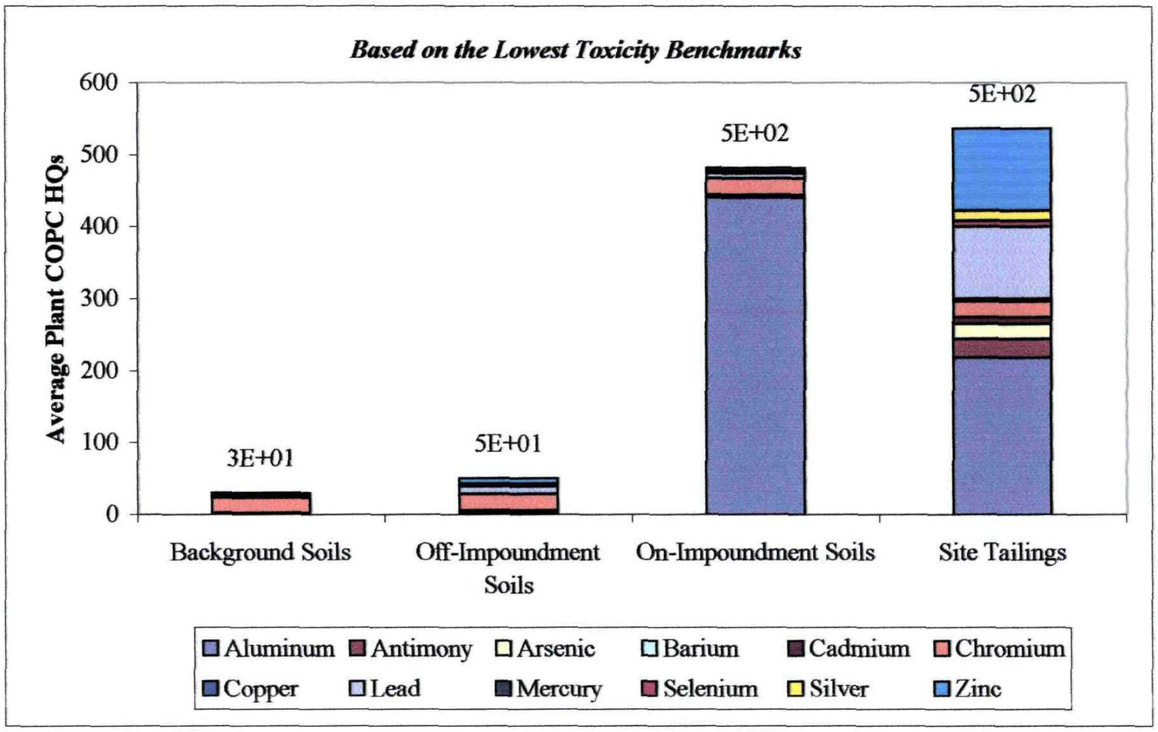
TOTAL HI



Plant Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

Figure 7-11
Contribution of COPCs to the Total HI for Plants from Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flats Tailings



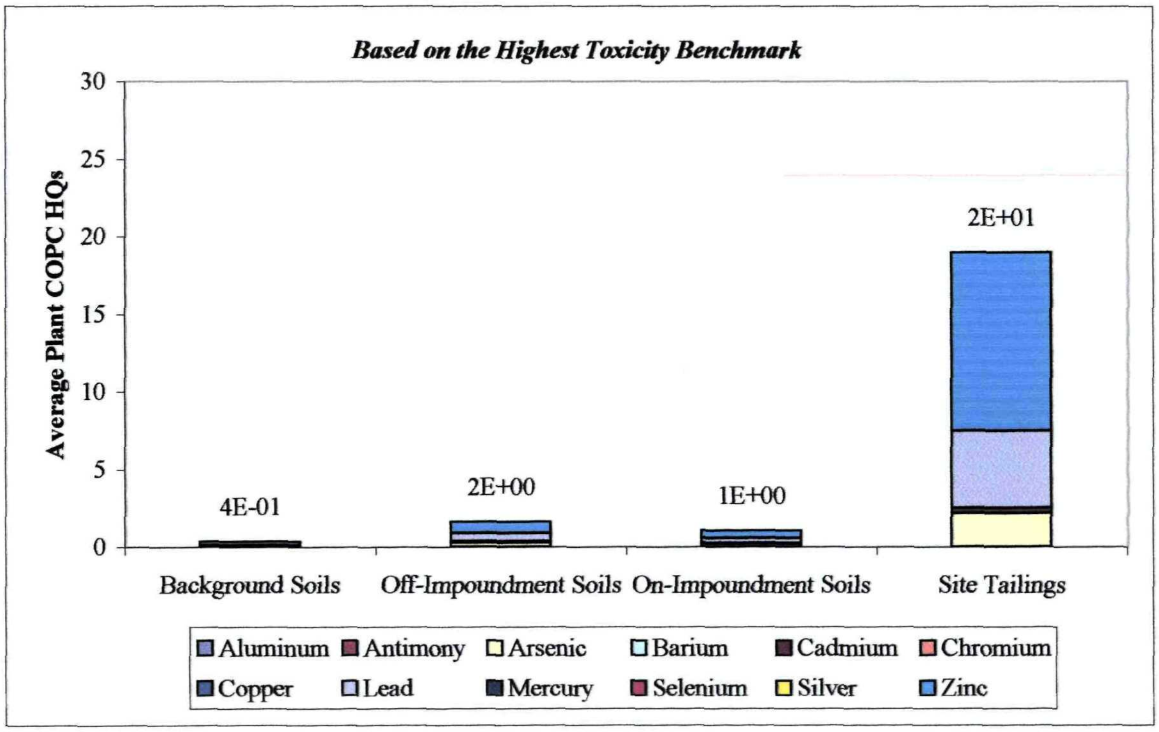
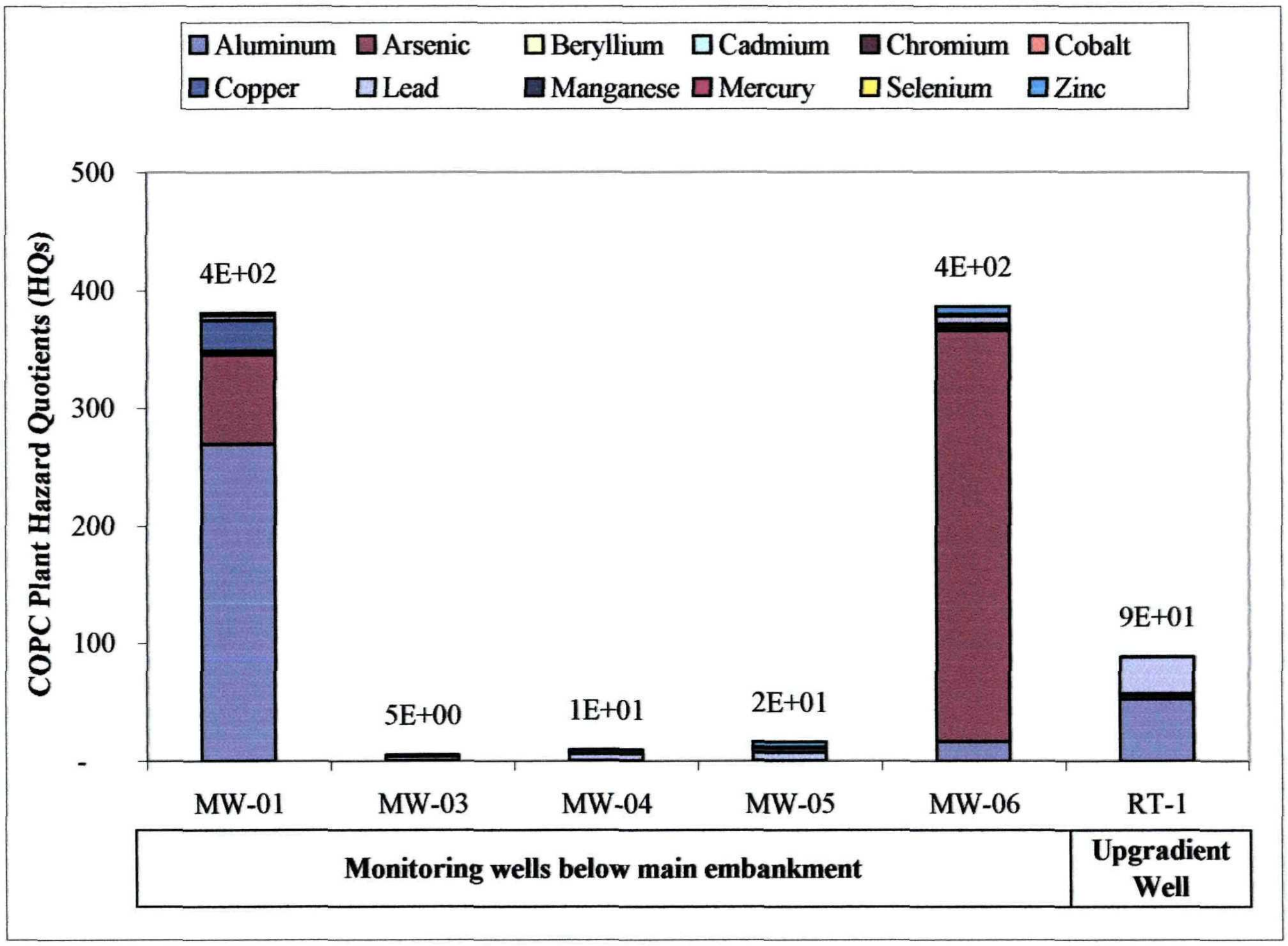


Figure 7-12
Contribution of COPCs to the Total HI for Plants from Direct Contact with Seep Water

Screening Ecological Risk Assessment for Richardson Flats Tailings

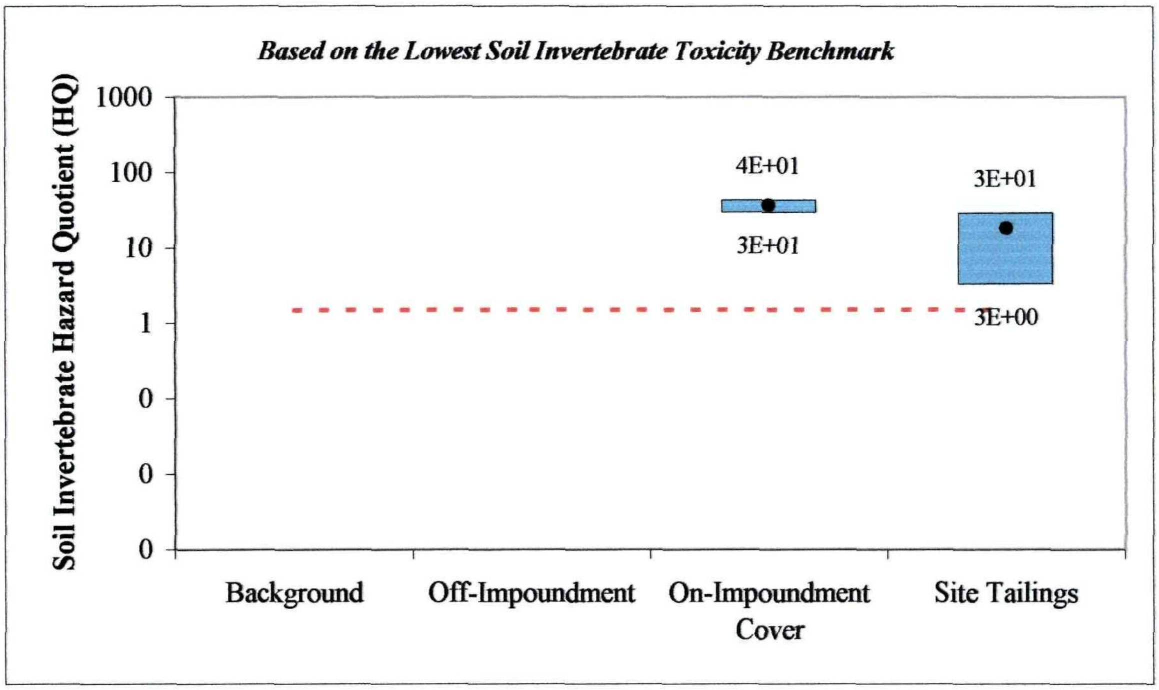


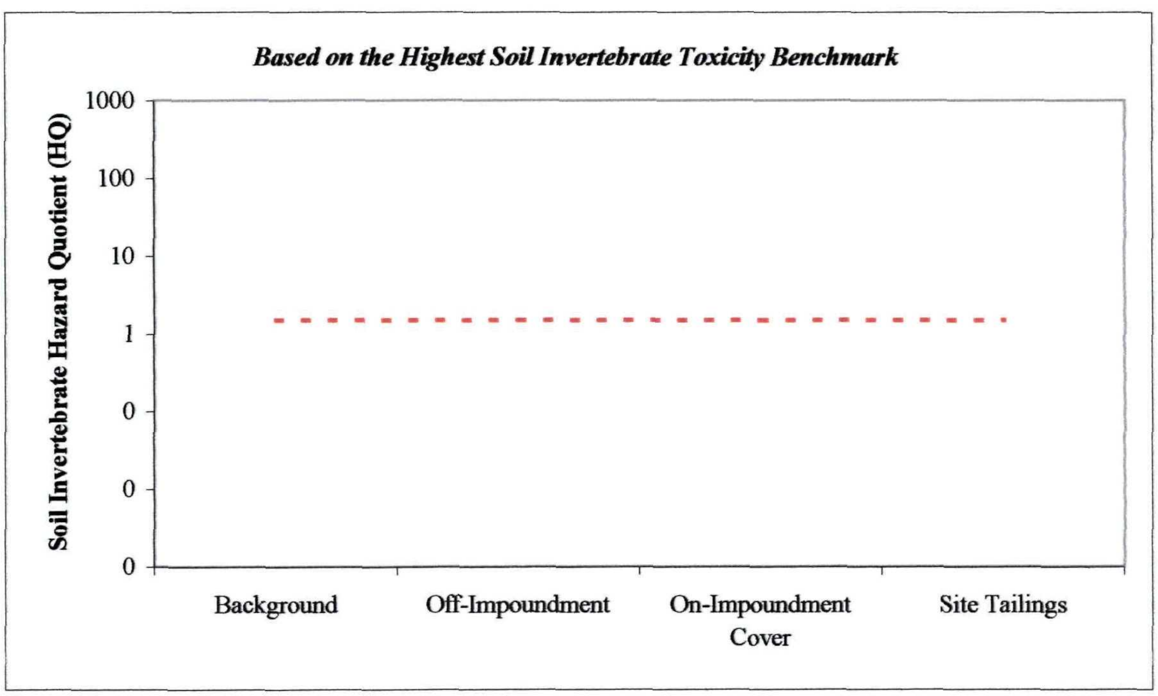
The Total HI is presented at the top of each stacked bar.
*Seep concentrations are estimated from available groundwater data.

Figure 7-13
Soil Fauna Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Aluminum



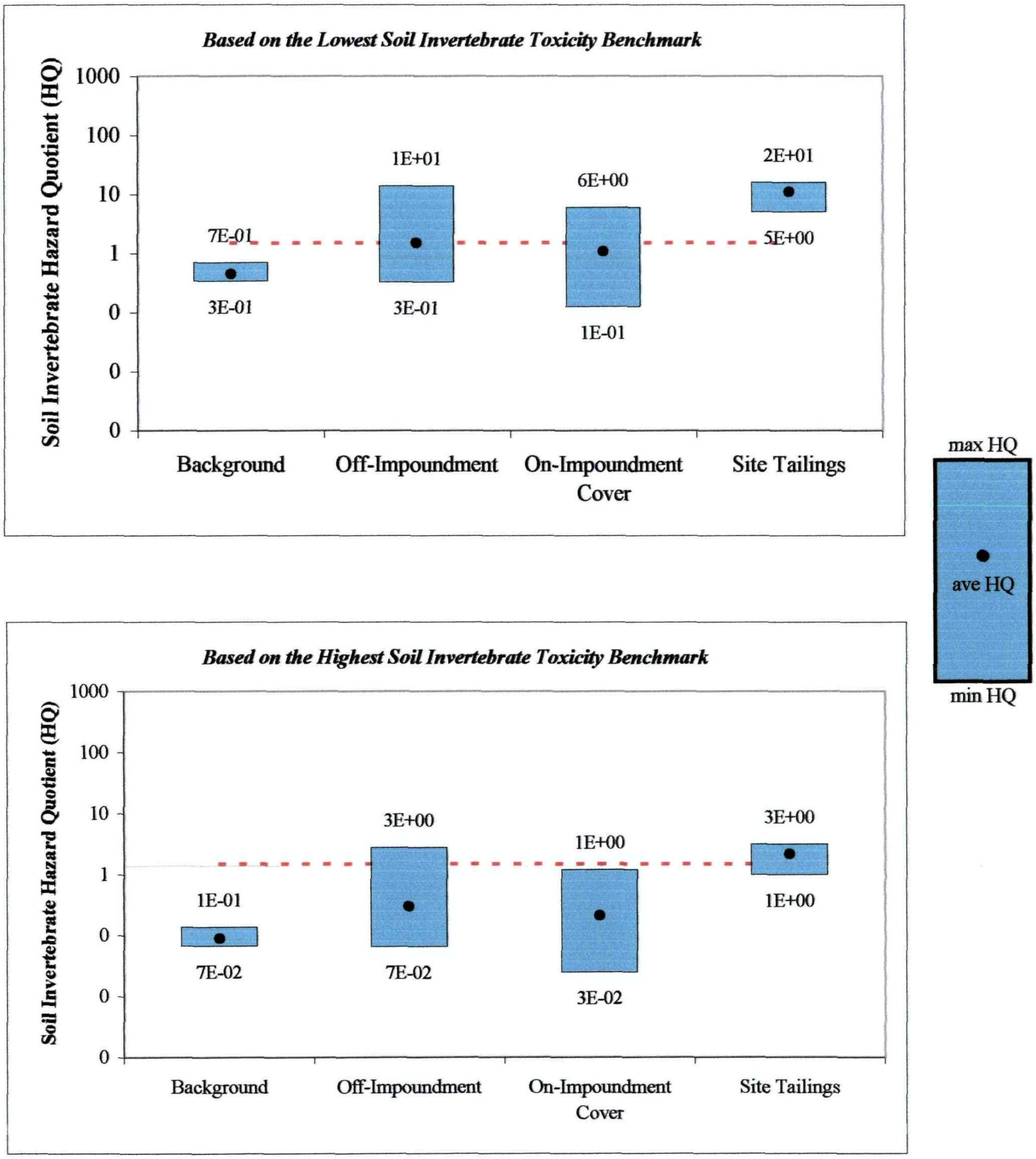


Soil Invertebrate Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locationss.
Soil Invert Risk_Soil Distrib rev.xls: Summary by COPC
2/10/2002

Figure 7-13
Soil Fauna Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Arsenic



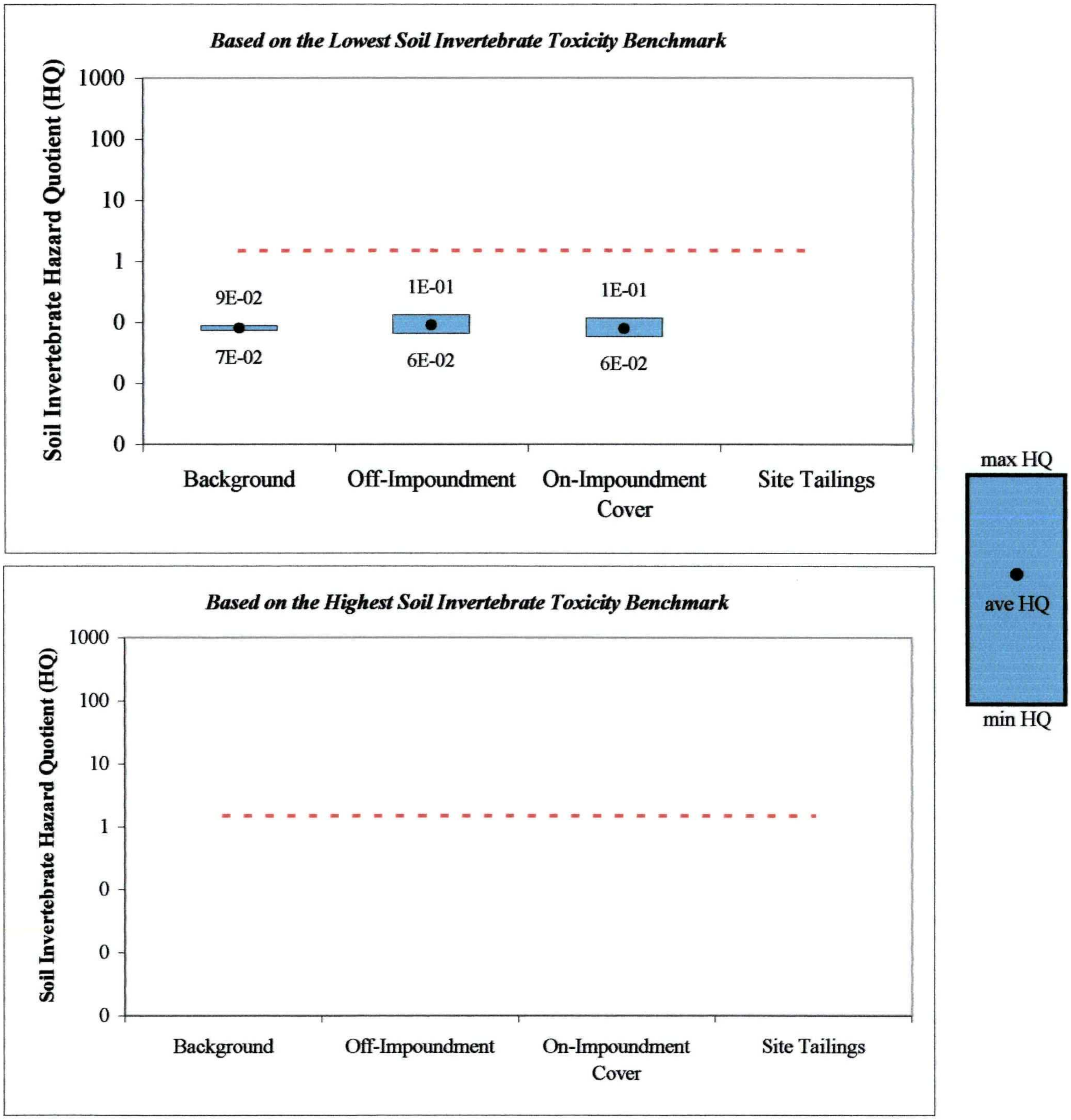
Soil Invertebrate Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locationss.

Soil Invert Risk_Soil Distrib rev.xls: Summary by COPC
2/10/2002

Figure 7-13
Soil Fauna Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Barium

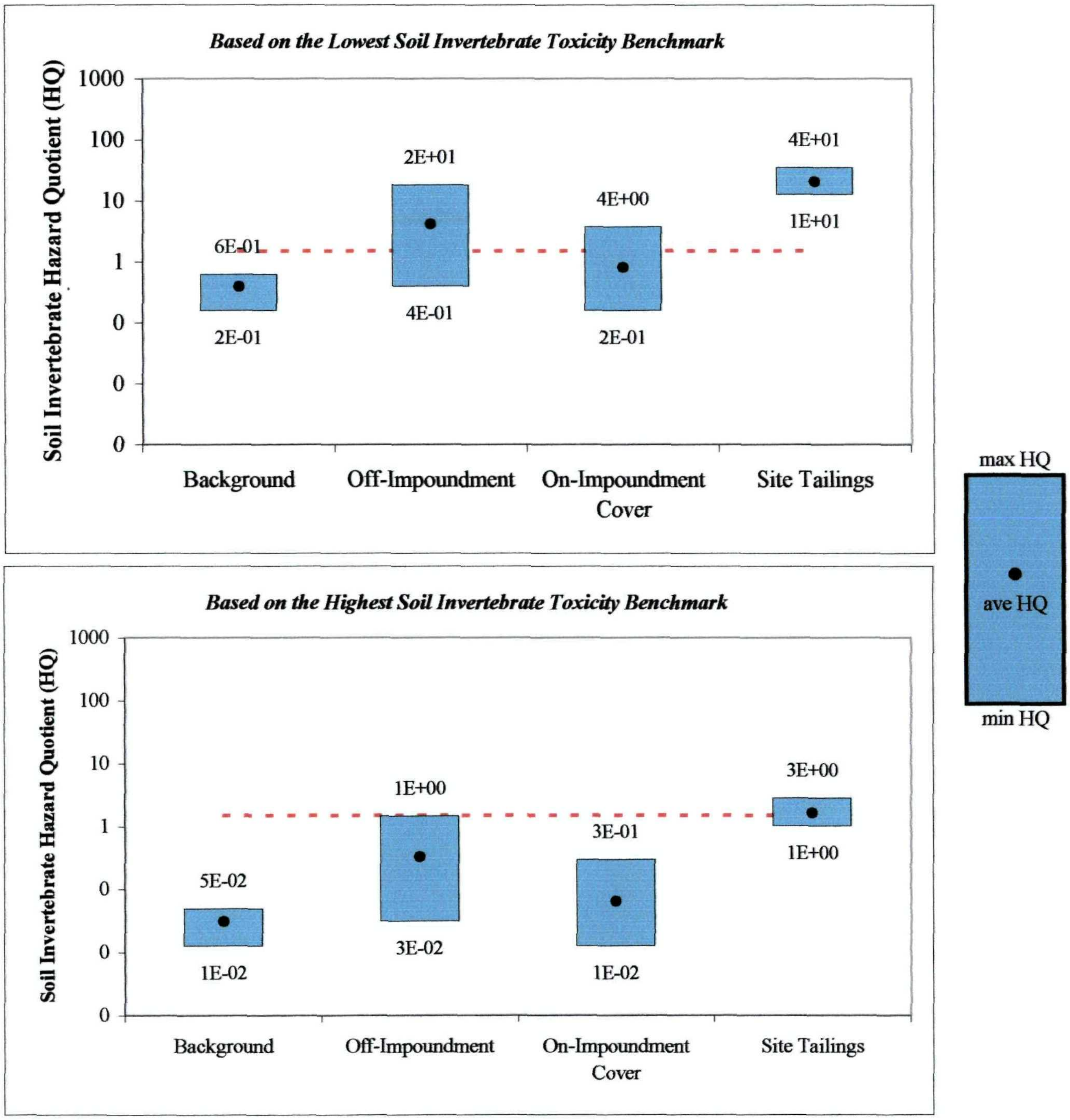


Soil Invertebrate Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

Figure 7-13
Soil Fauna Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Cadmium

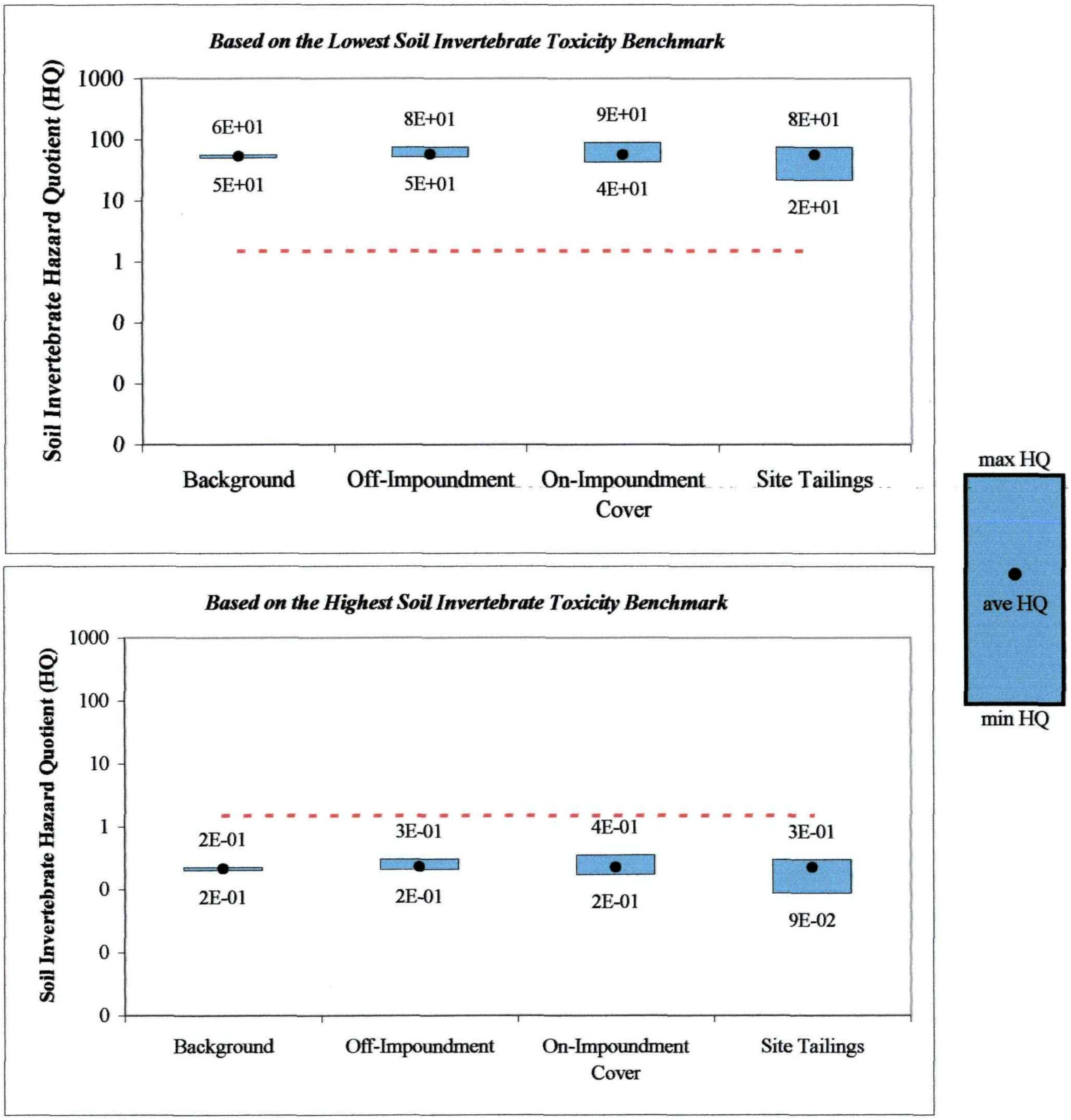


Soil Invertebrate Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

Figure 7-13
Soil Fauna Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Chromium

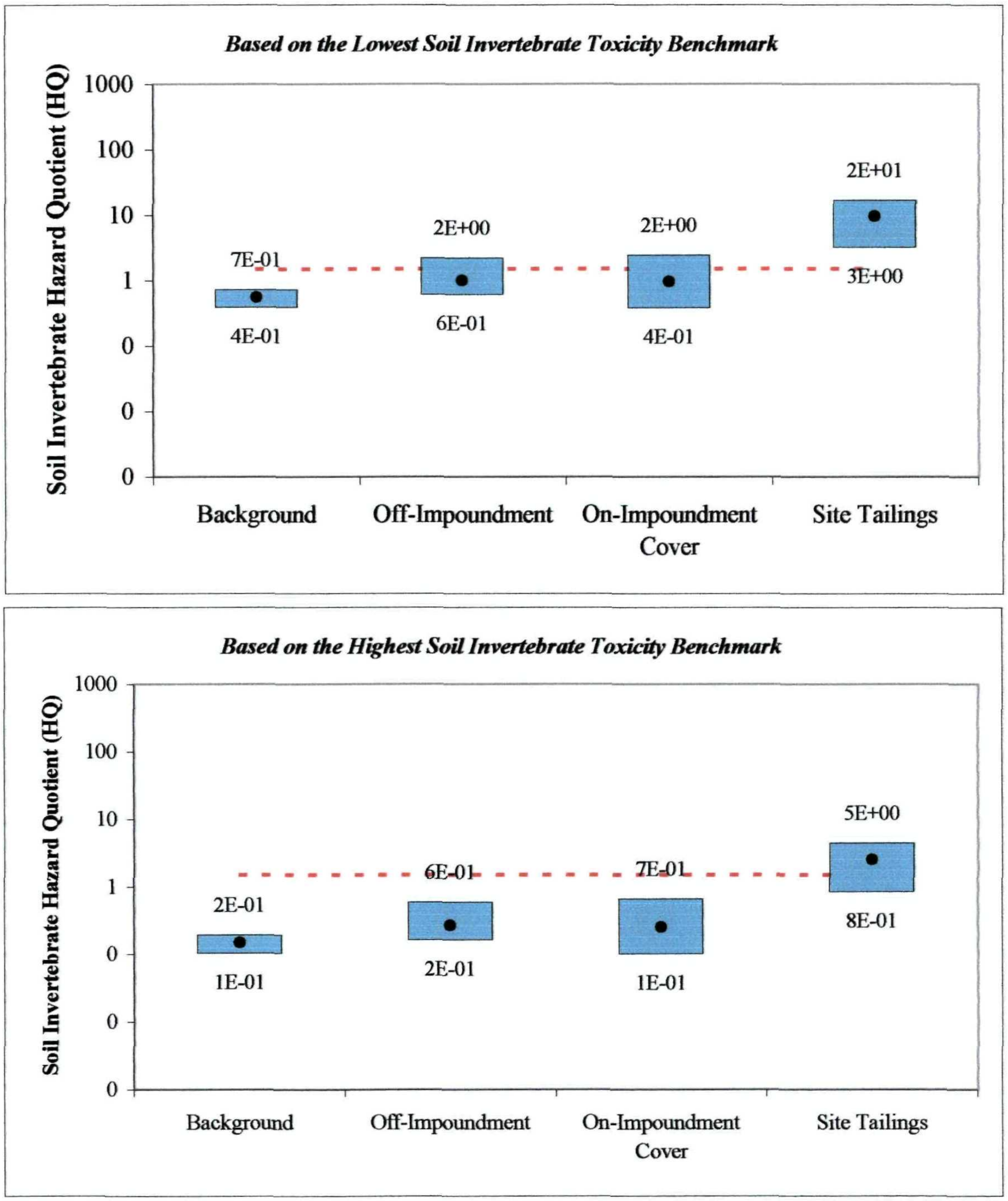


Soil Invertebrate Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

Figure 7-13
Soil Fauna Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Copper

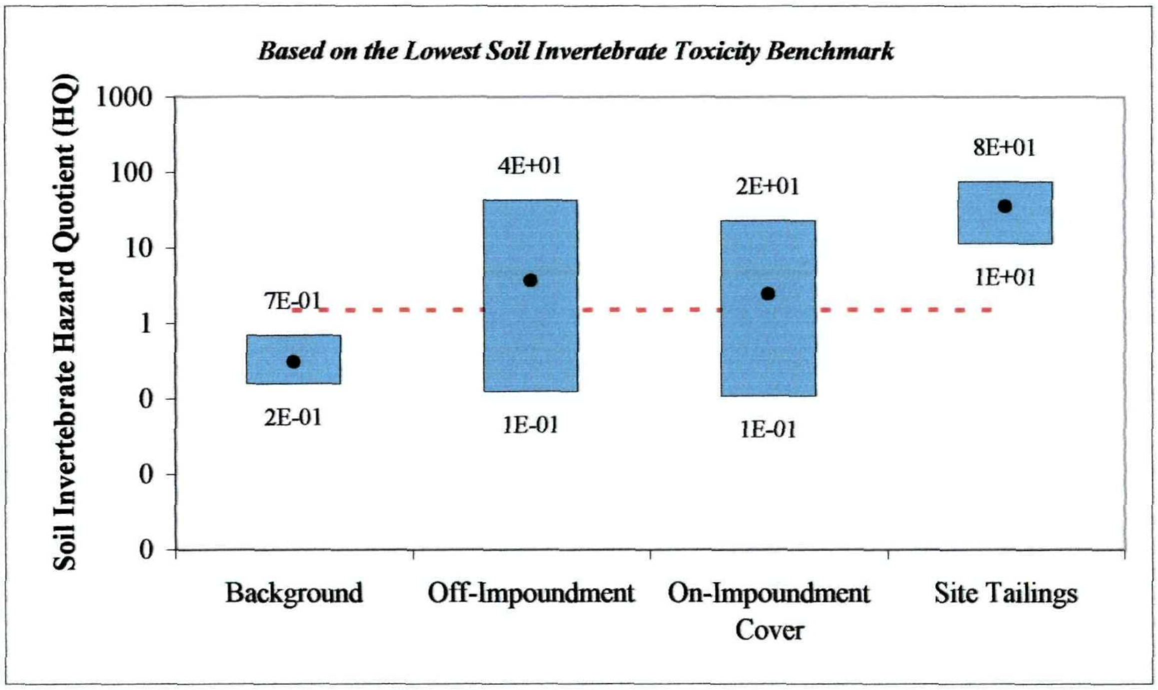


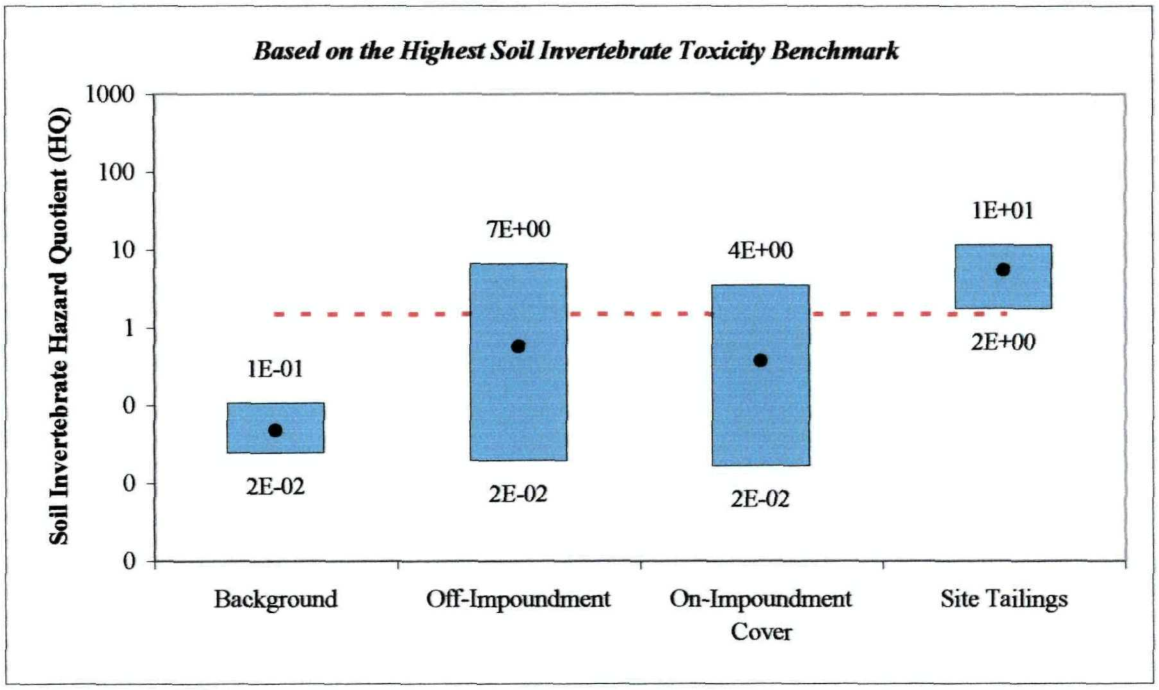
Soil Invertebrate Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

Figure 7-13
Soil Fauna Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Lead



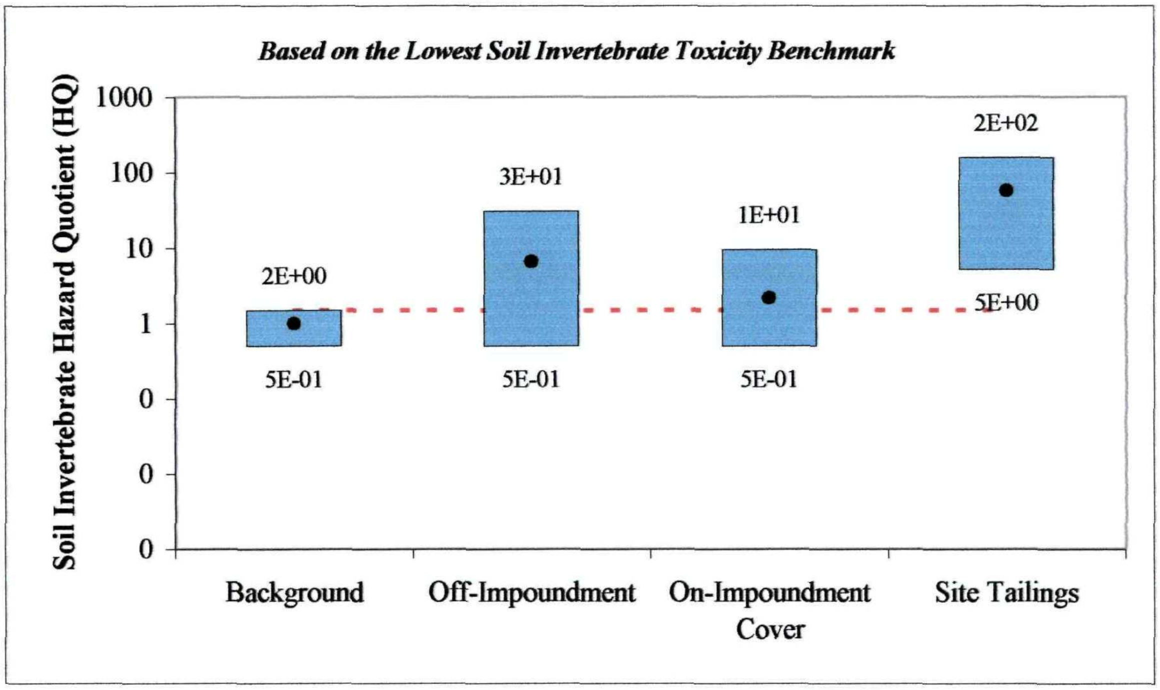


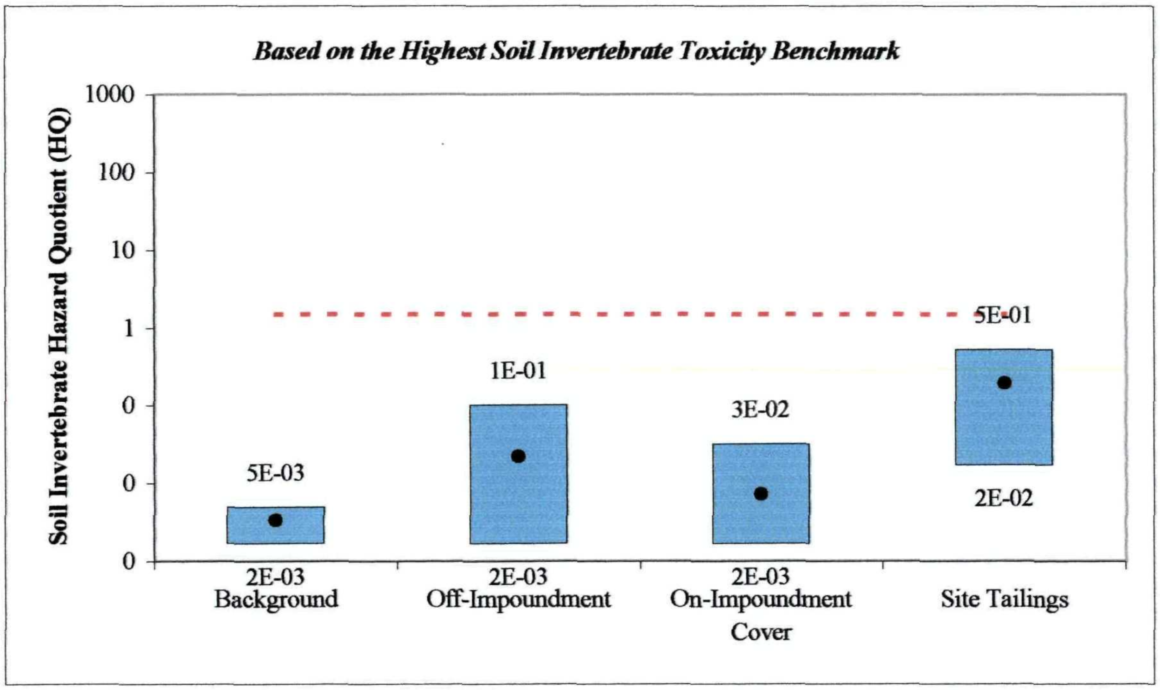
Soil Invertebrate Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

Figure 7-13
Soil Fauna Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Mercury



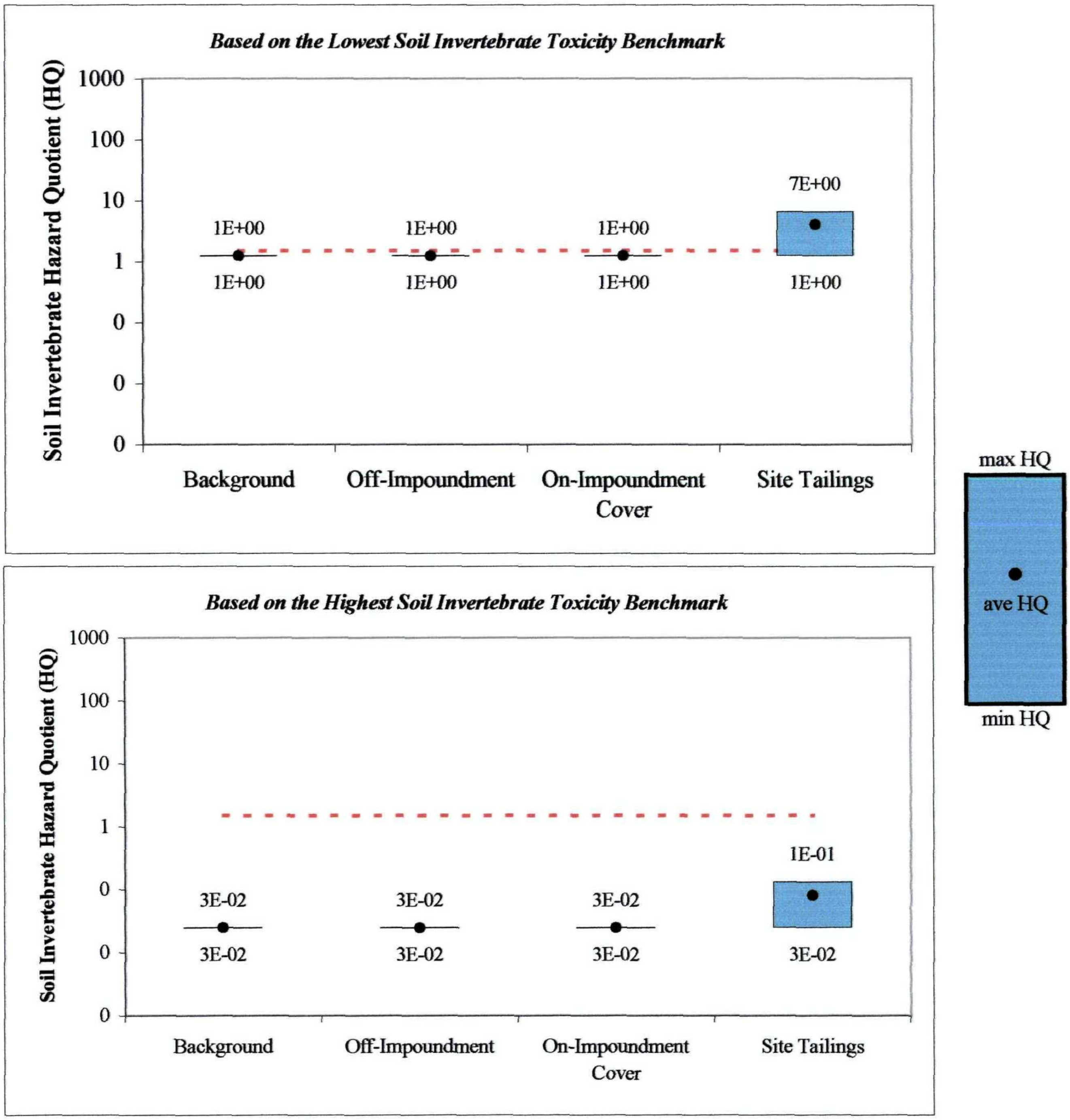


Soil Invertebrate Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

Figure 7-13
Soil Fauna Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Selenium

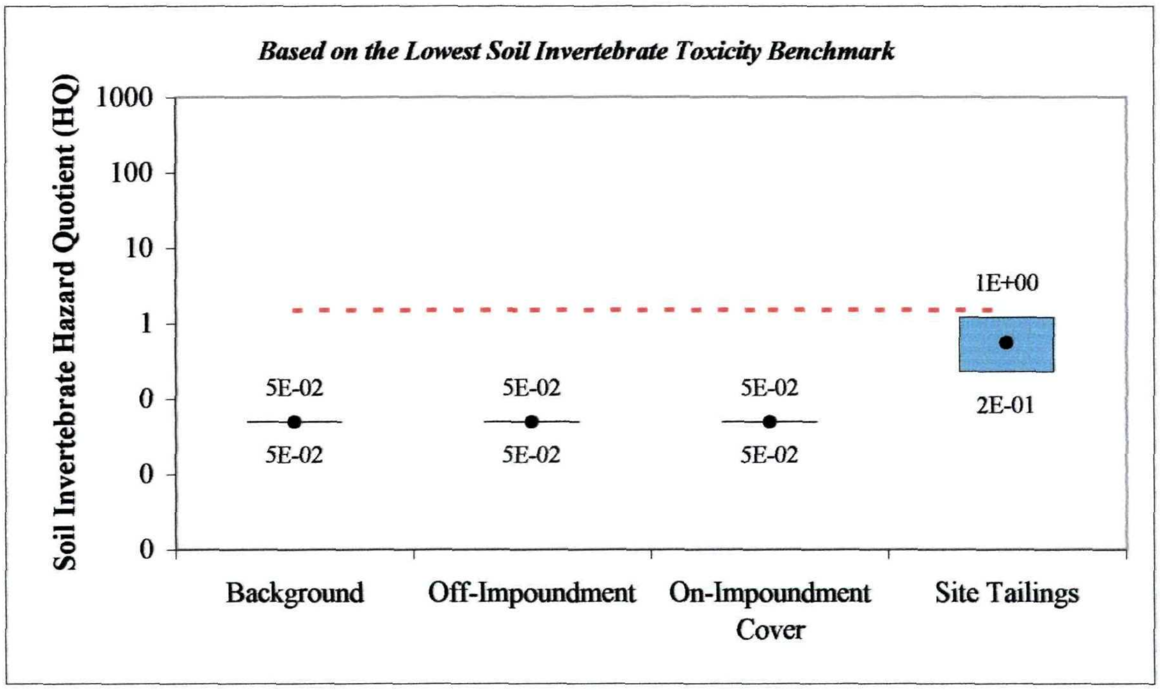


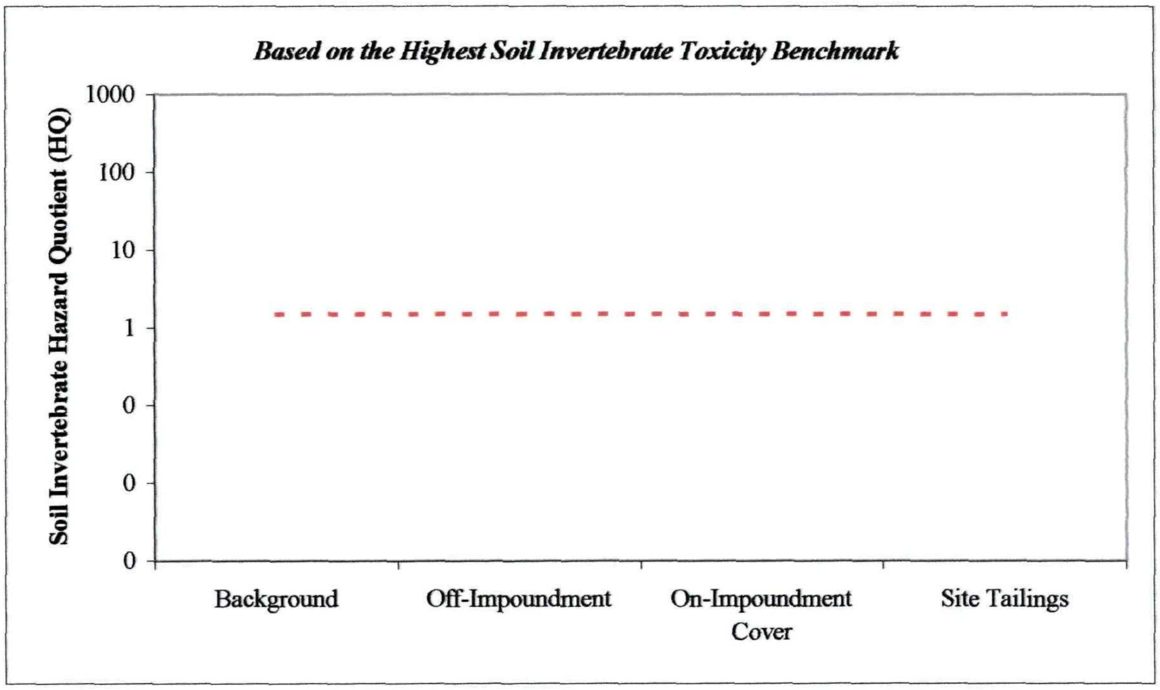
Soil Invertebrate Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

Figure 7-13
Soil Fauna Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Silver



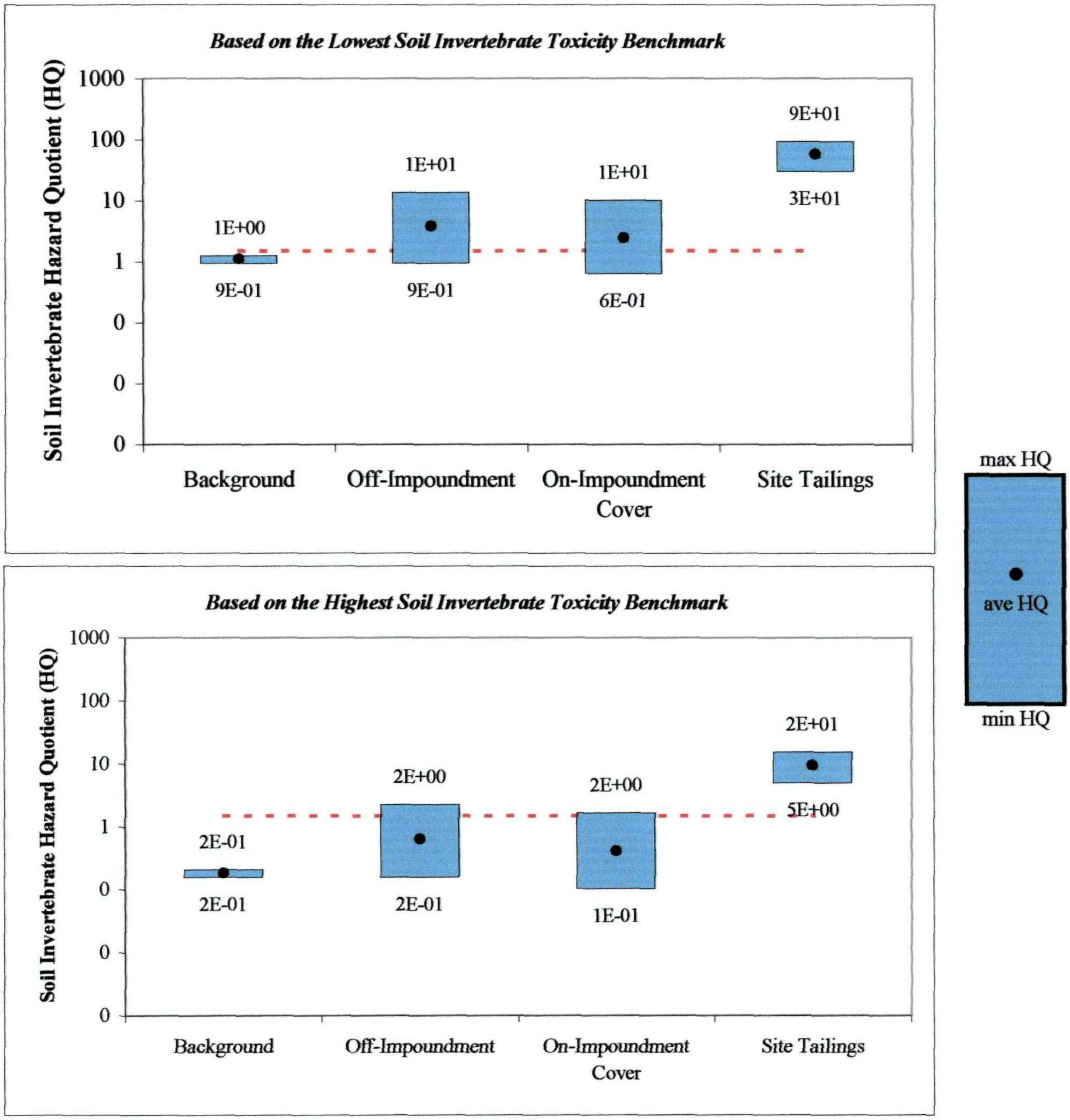


Soil Invertebrate Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

Figure 7-13
Soil Fauna Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

Zinc

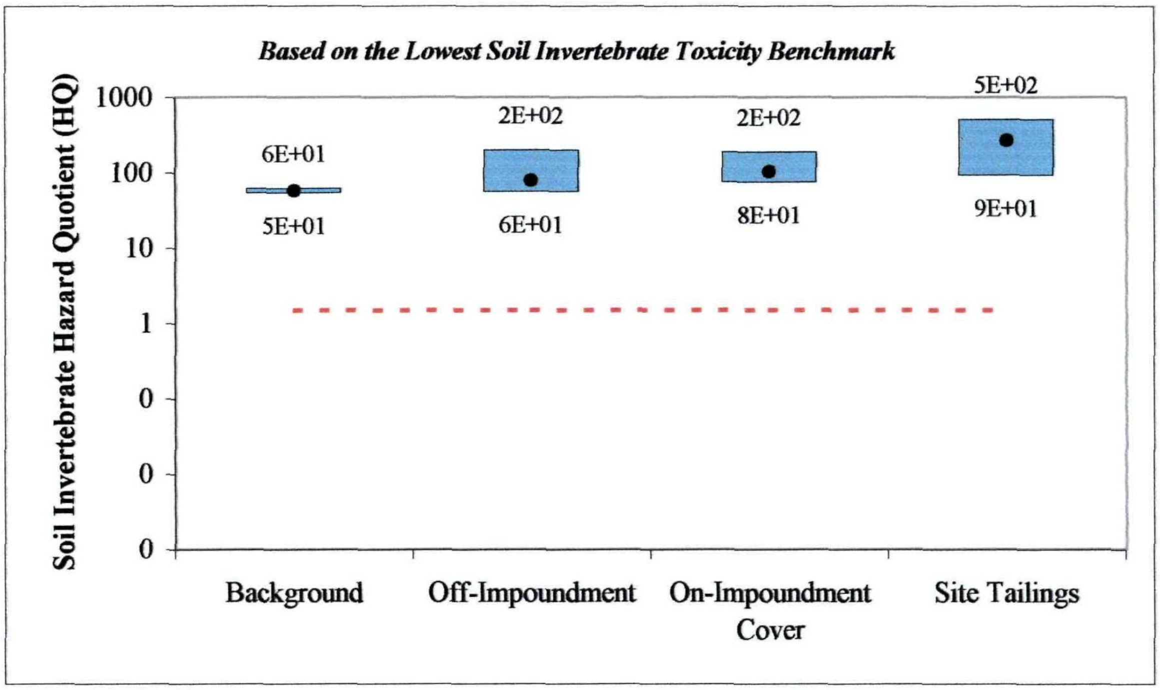


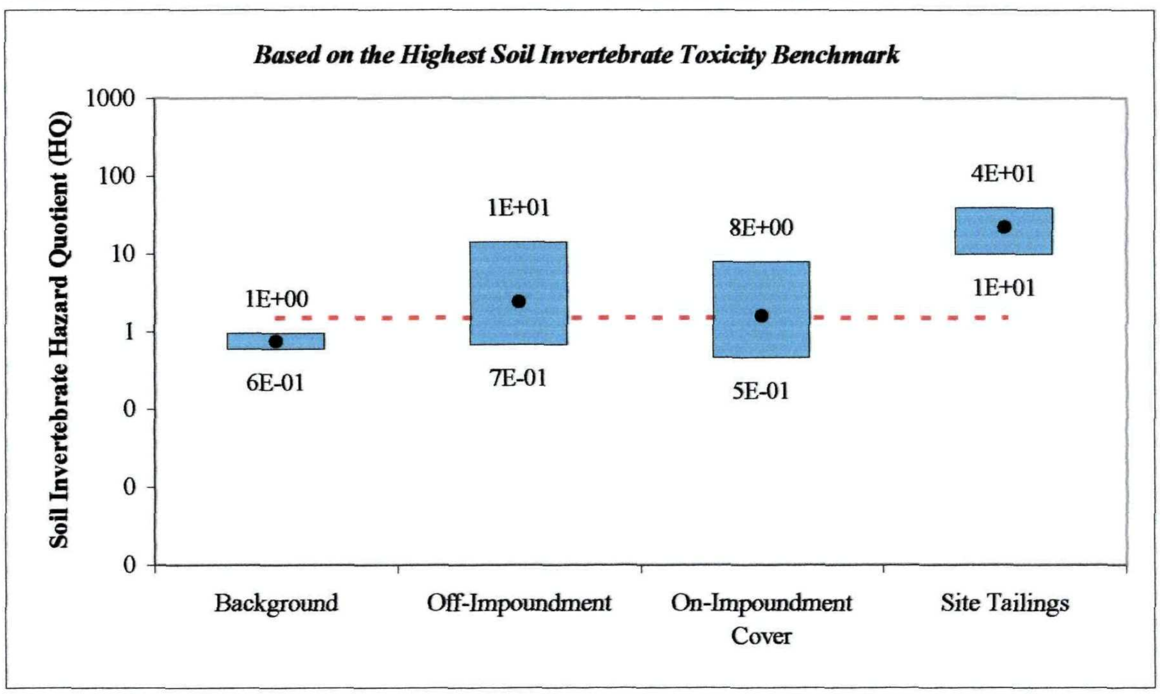
Soil Invertebrate Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

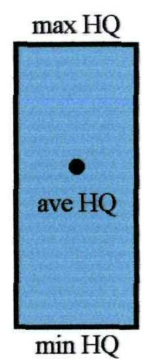
Figure 7-13
Soil Fauna Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings Site

TOTAL HI



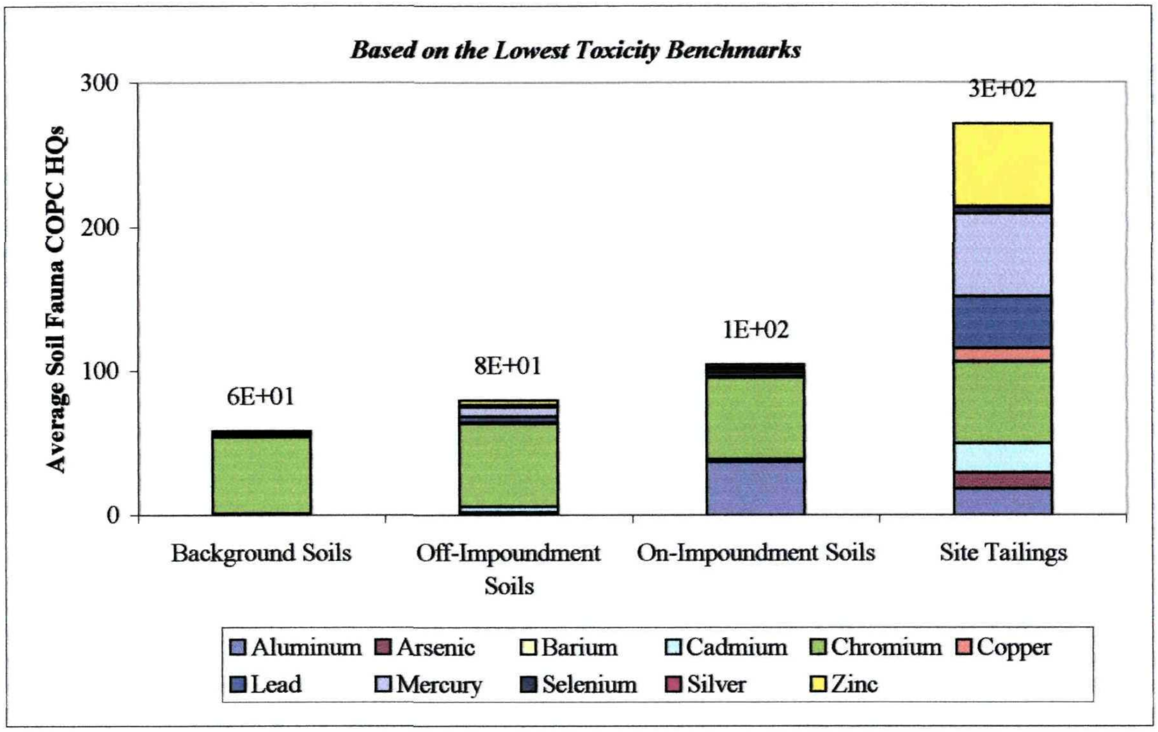




Soil Invertebrate Hazard Quotients are based on samples collected from 10 background, 35 off-impoundment, 41 on-impoundment cover, and 10 tailings locations.

Figure 7-14
Contribution of COPCs to the Total HI for Soil Fauna from Direct Contact with Soils and Tailings

Screening Ecological Risk Assessment for Richardson Flats Tailings



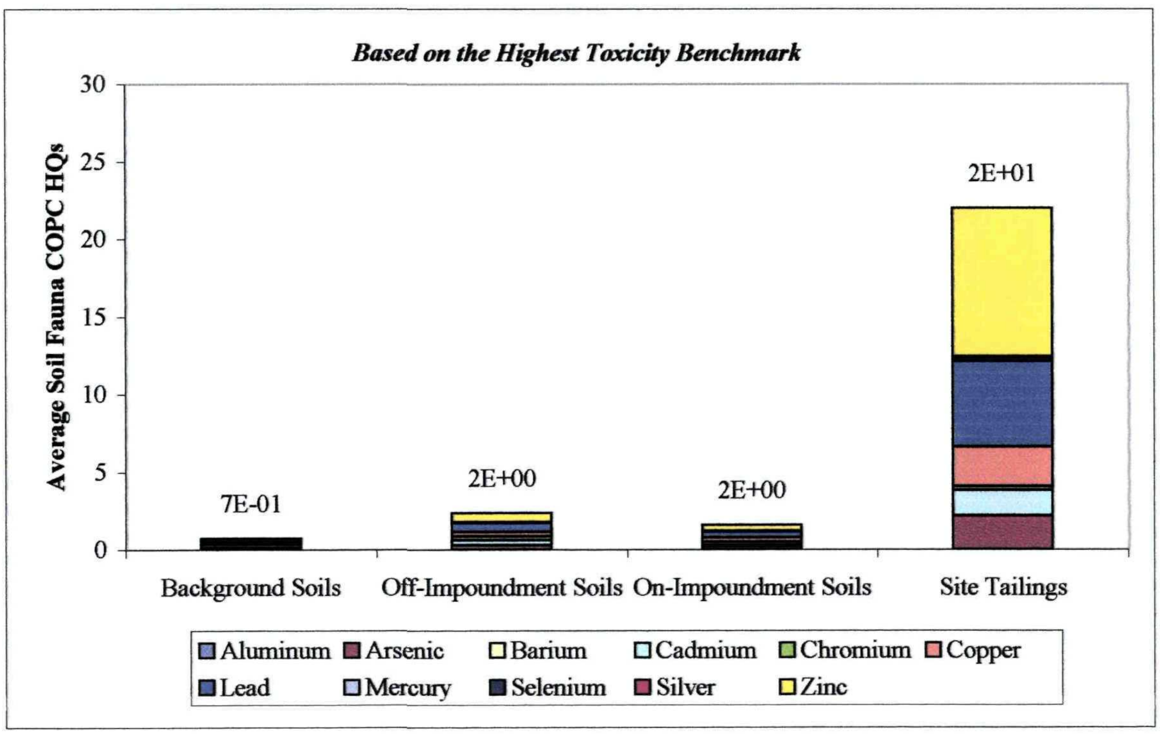
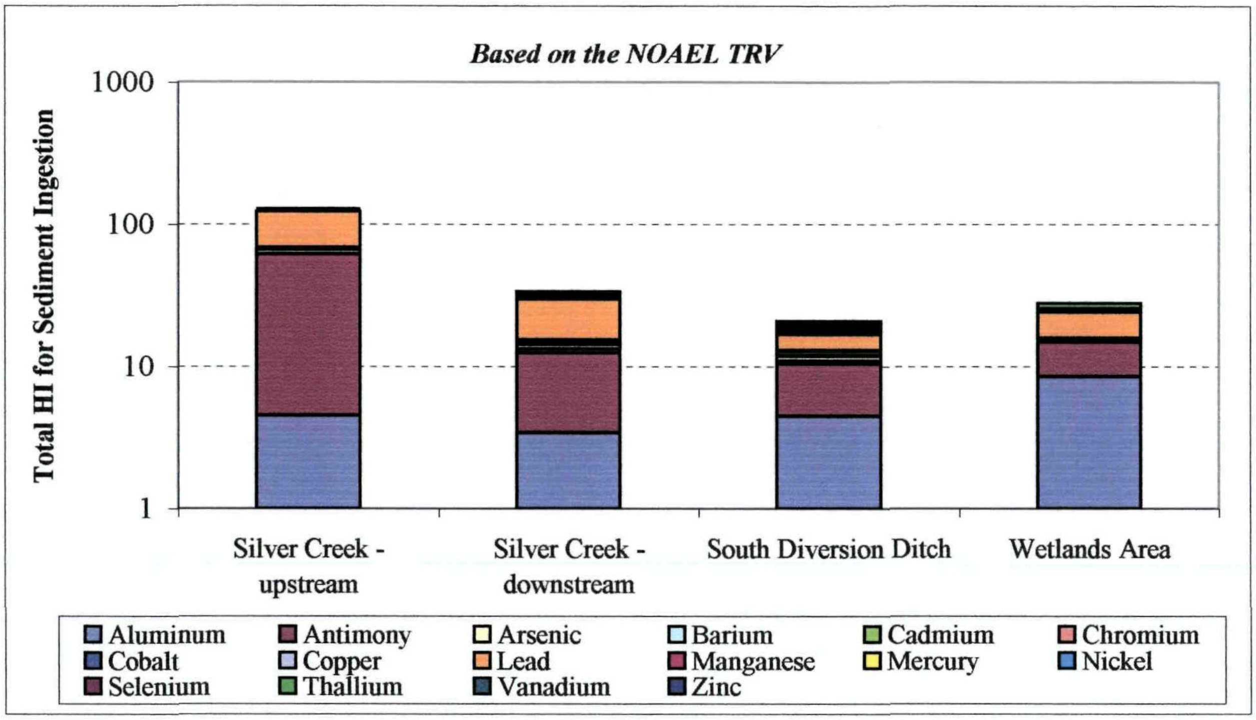


Figure 7-15
Contribution of Each COPC to the Total HI for Ingestion of Sediment

Screening Ecological Risk Assessment for Richardson Flat Tailings

Mink



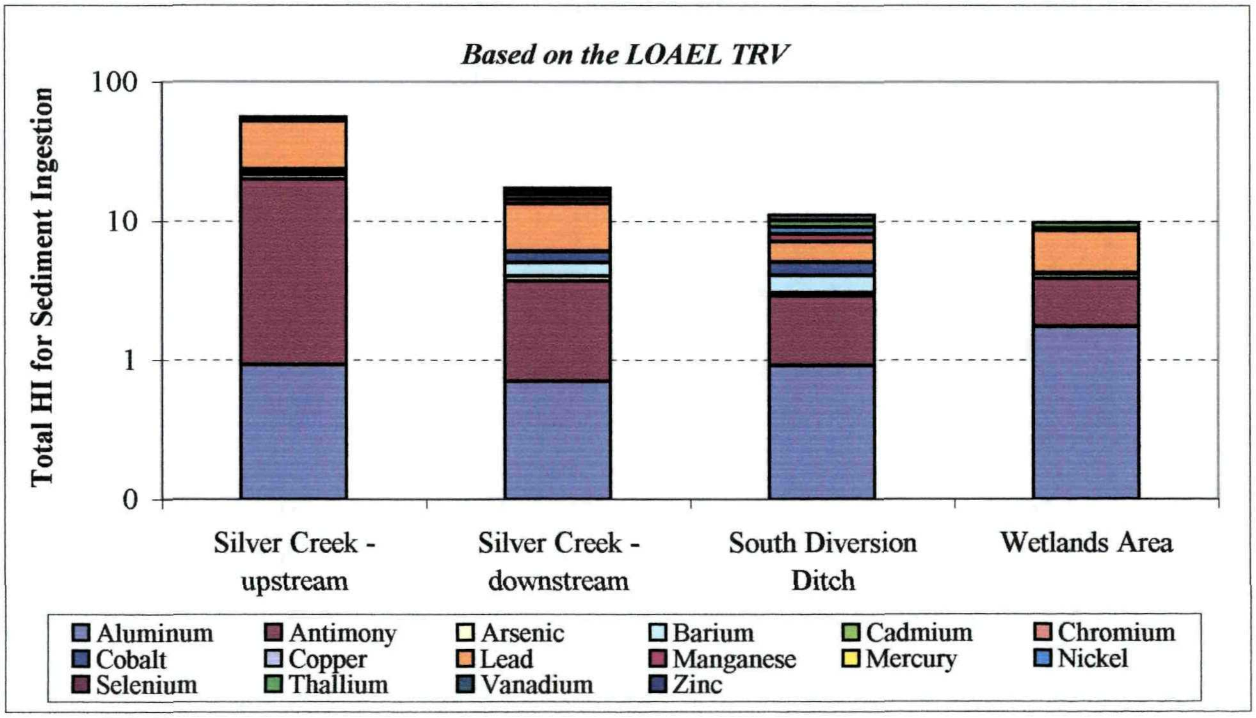
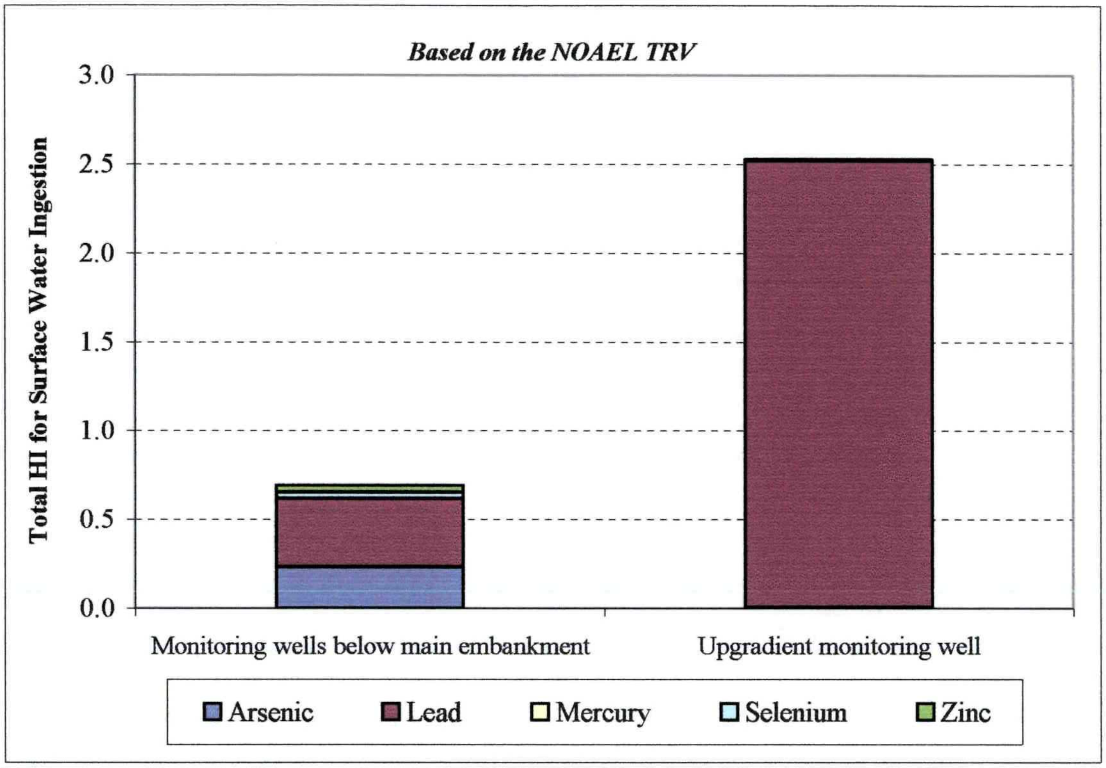
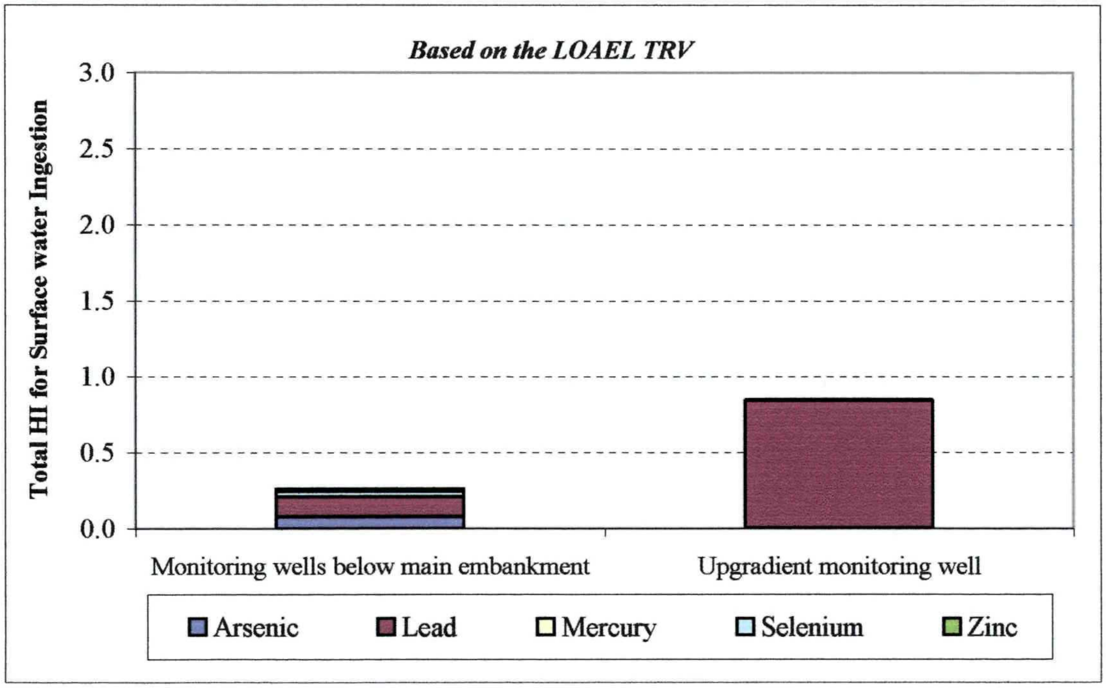


Figure 7-16
Contribution of Each COPC to the Total HI for Ingestion of Seep* Water

Screening Ecological Risk Assessment for Richardson Flat Tailings

Masked Shrew



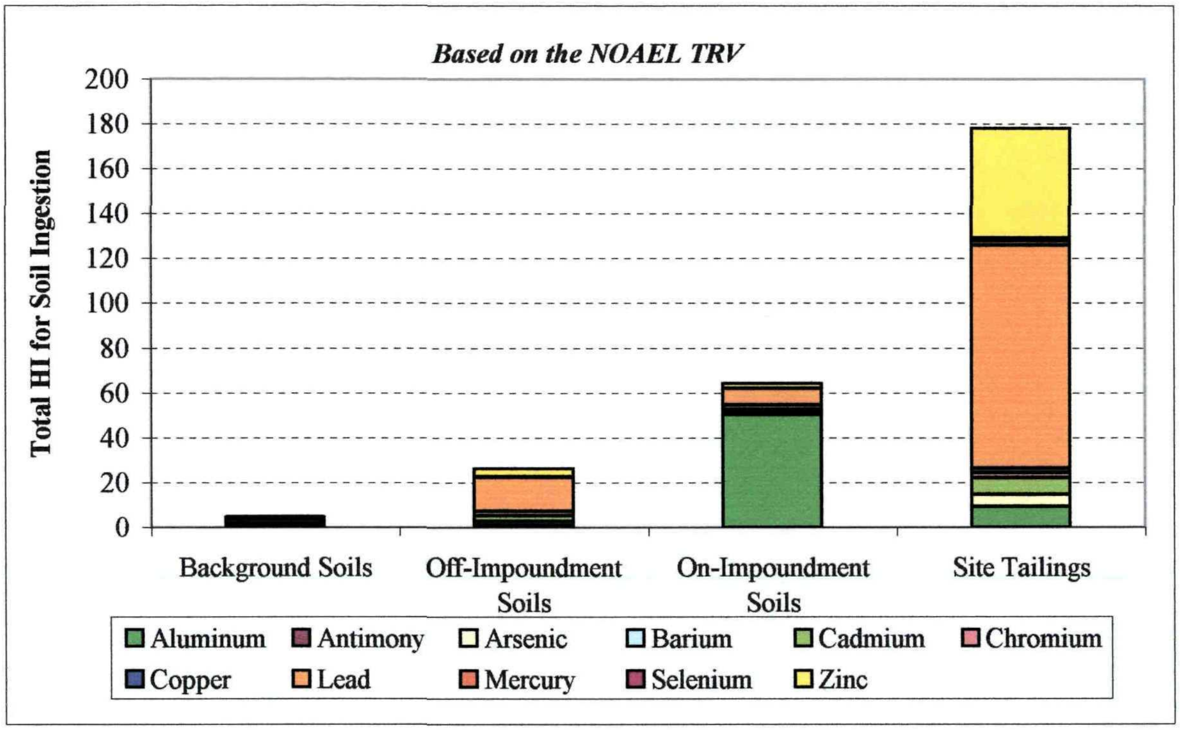


***Seep concentrations are estimated using available groundwater data.**

Figure 7-17
Contribution of Each COPC to the Total HI for Ingestion of Soil/Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings

American Robin



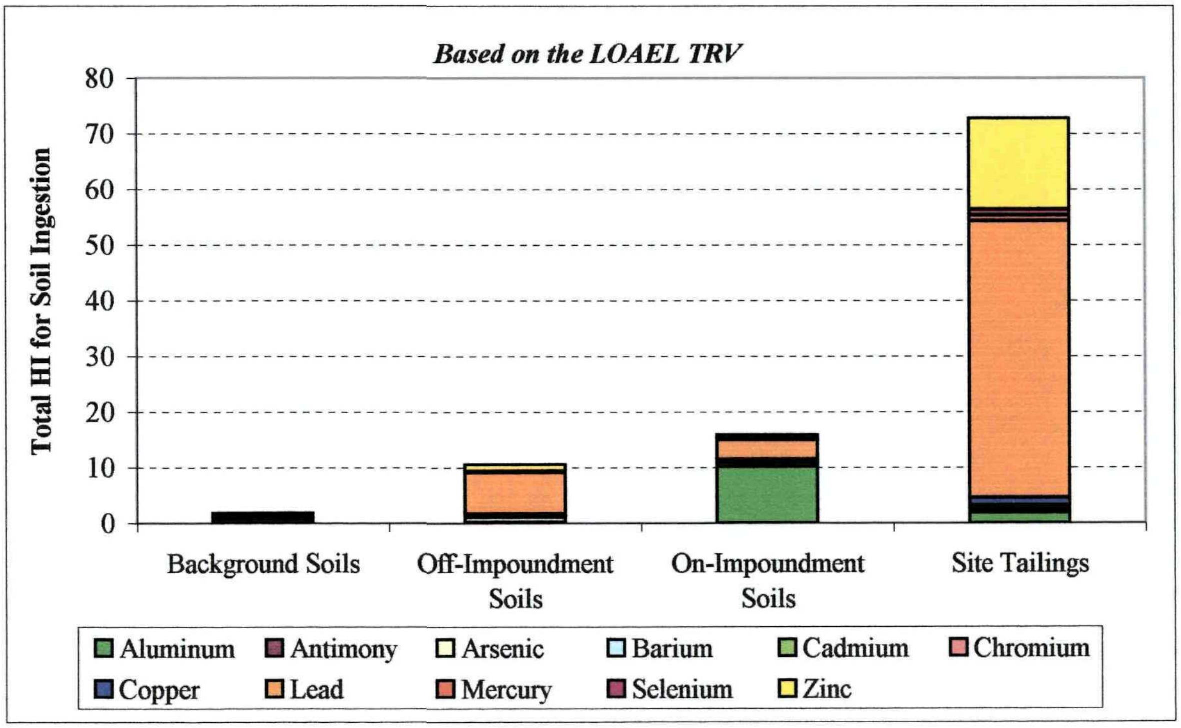
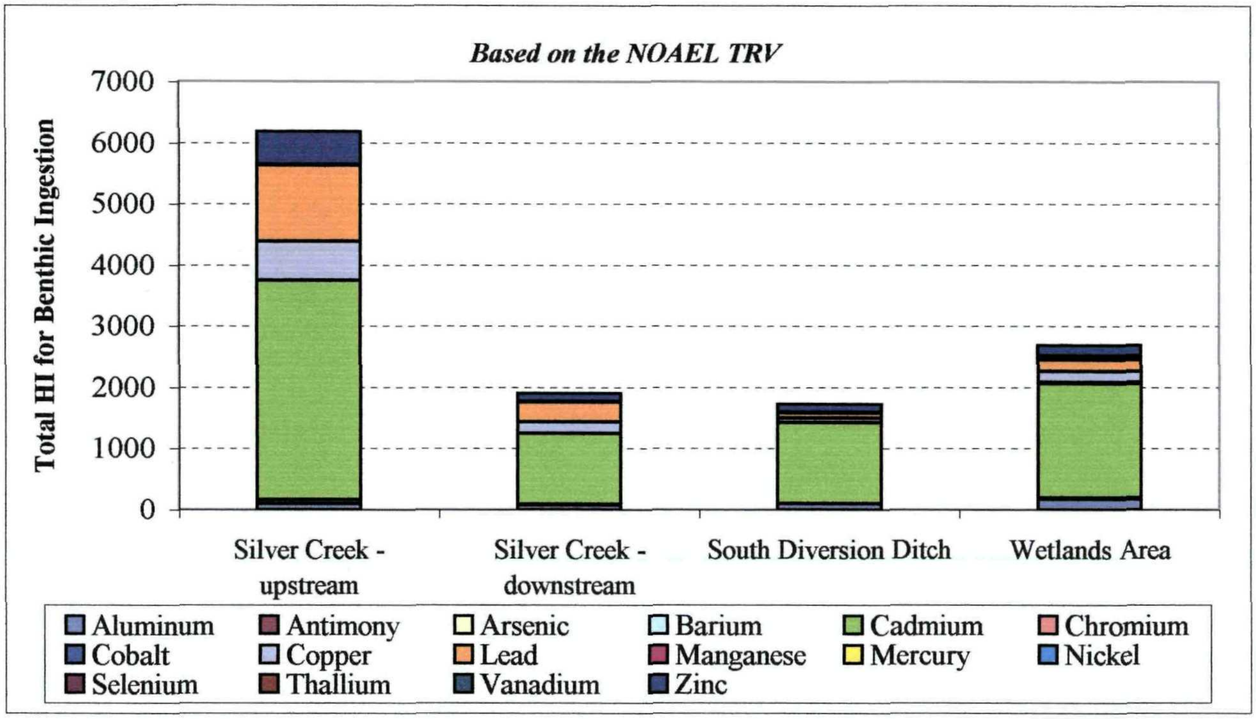


Figure 7-18
Contribution of Each COPC to the Total HI for Ingestion of Benthic Invertebrates

Screening Ecological Risk Assessment for Richardson Flat Tailings

Mallard Duck



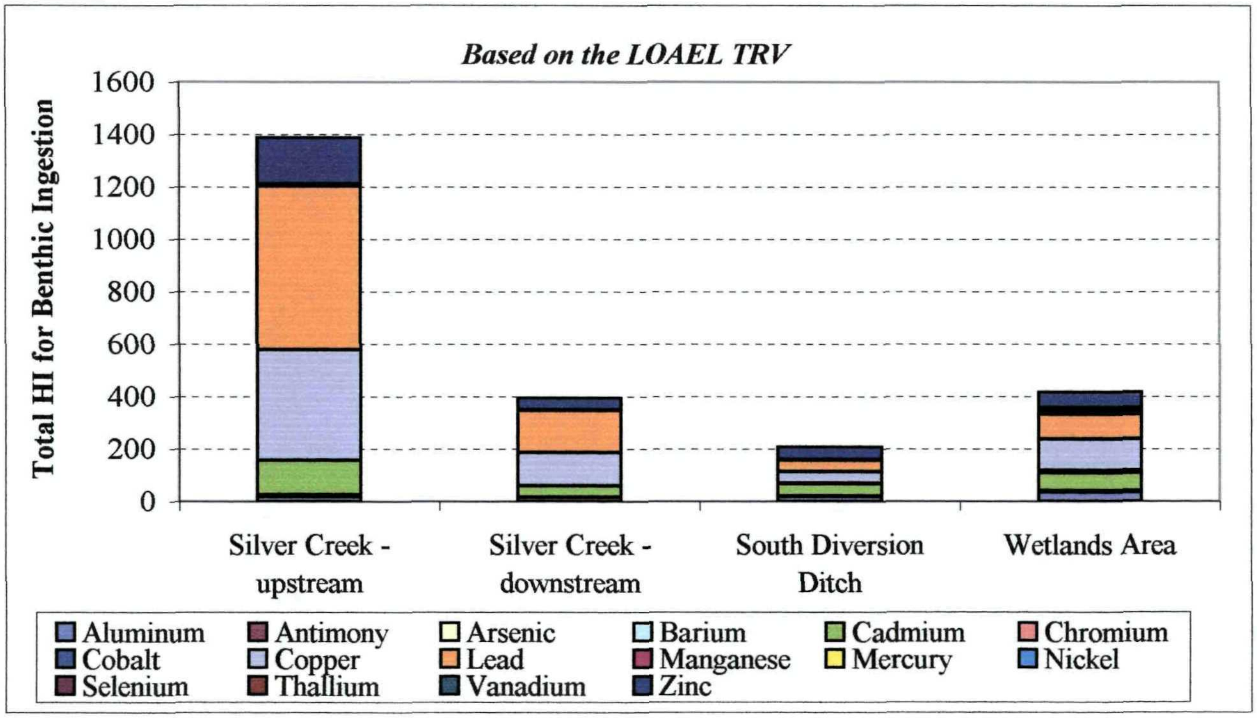
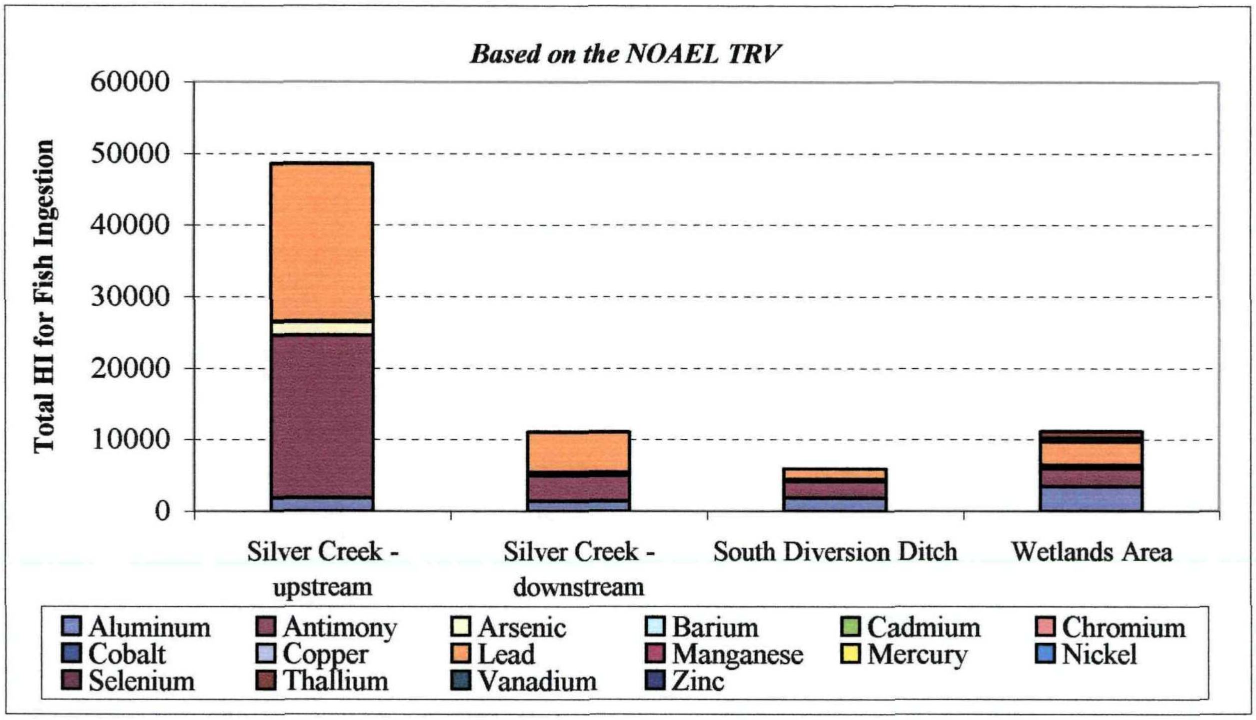


Figure 7-19
Contribution of Each COPC to the Total HI for Ingestion of Fish

Screening Ecological Risk Assessment for Richardson Flat Tailings

Mink



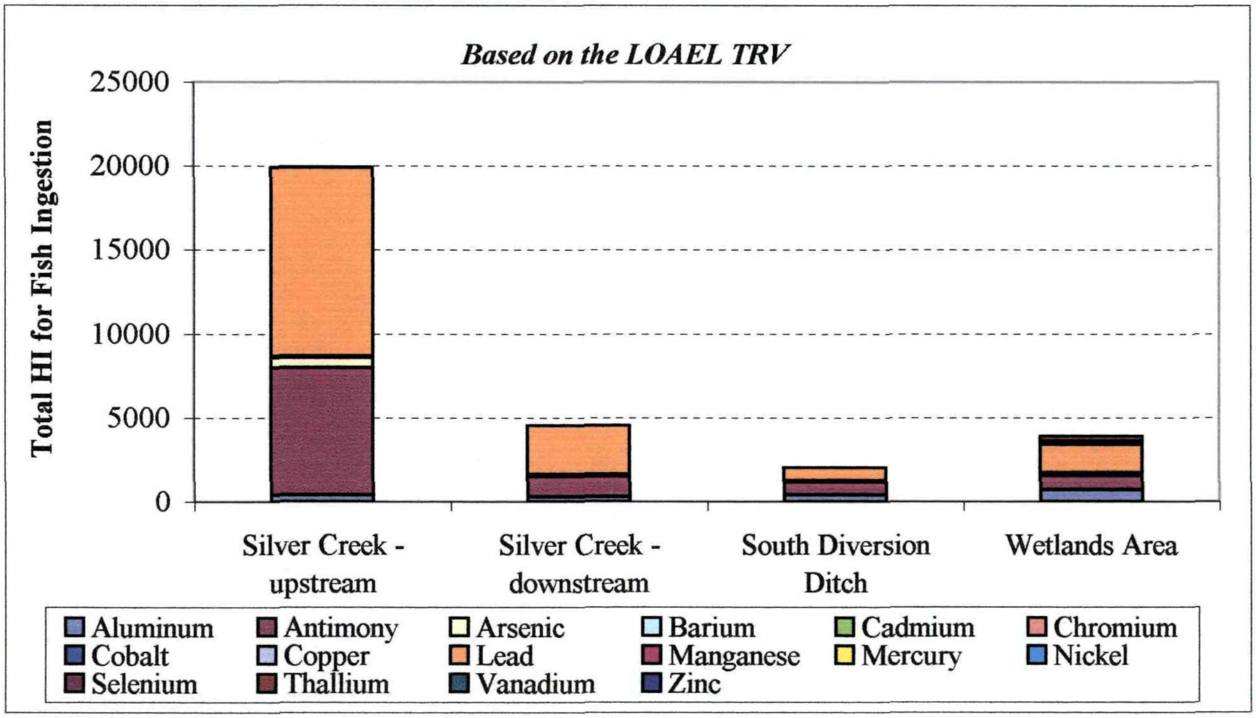
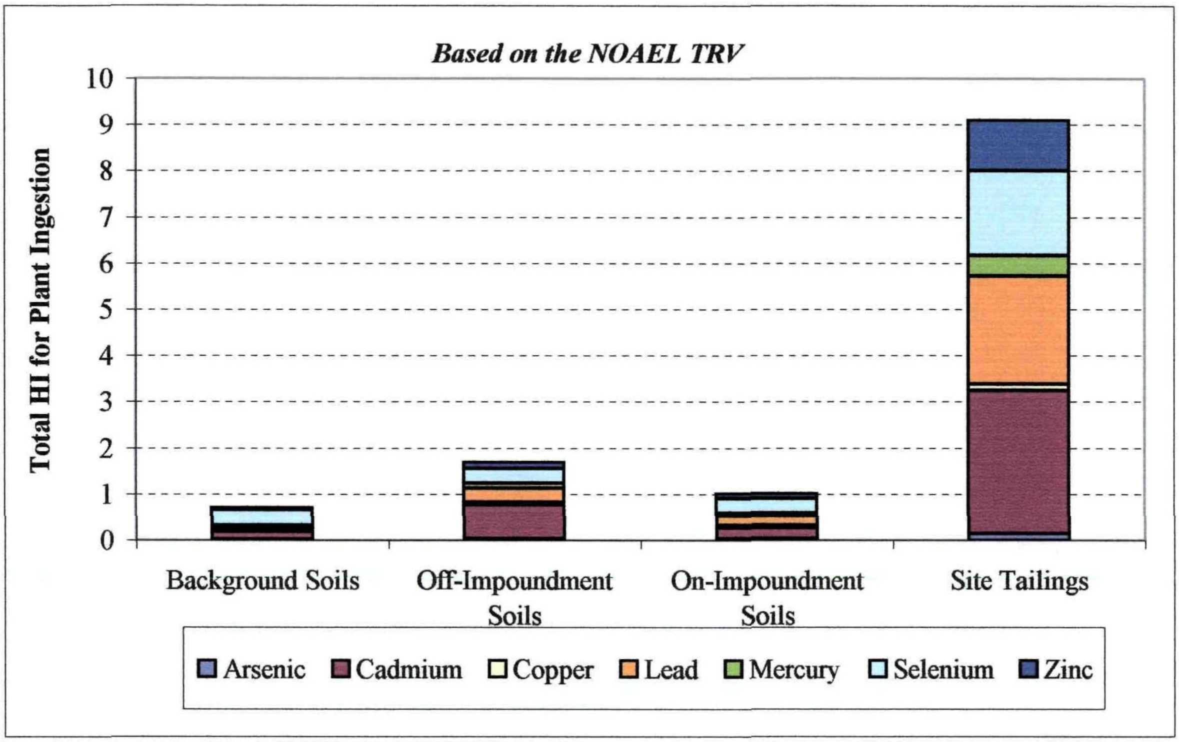


Figure 7-20
Contribution of Each COPC to the Total HI for Ingestion of Plants

Screening Ecological Risk Assessment for Richardson Flat Tailings

Greater-Sage Grouse



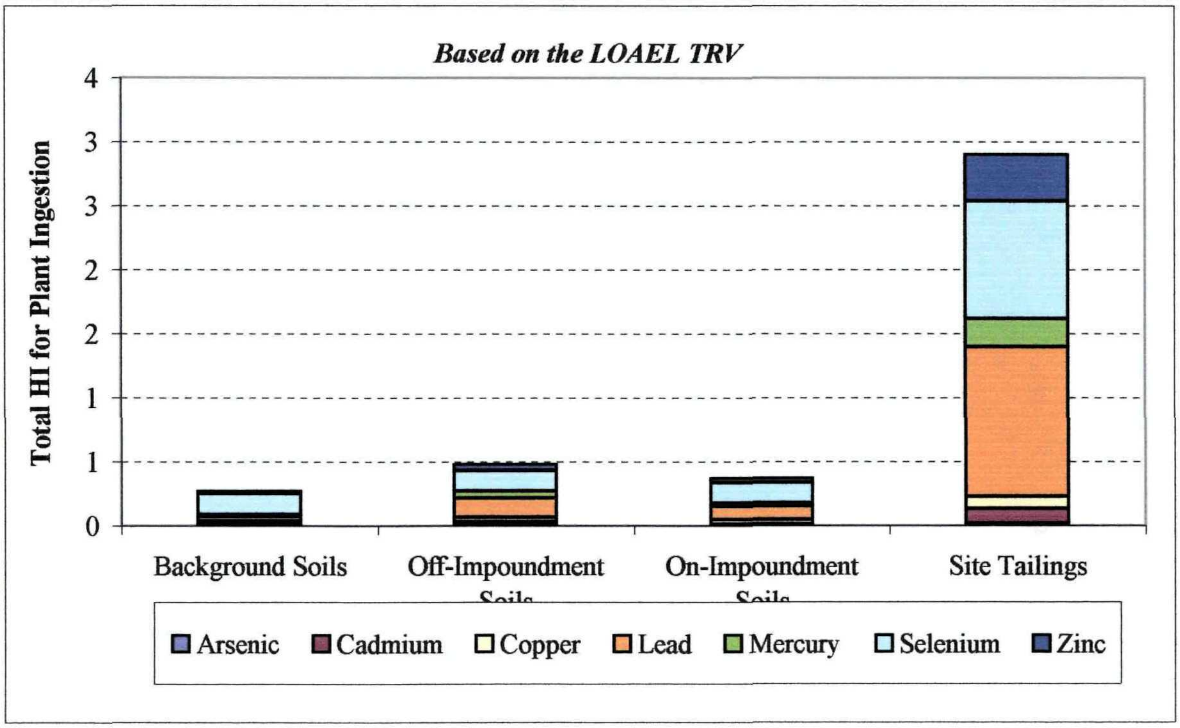


Figure 7-21
Contribution of Each COPC to the Total HI for Ingestion of Earthworms

Screening Ecological Risk Assessment for Richardson Flat Tailings

Masked Shrew

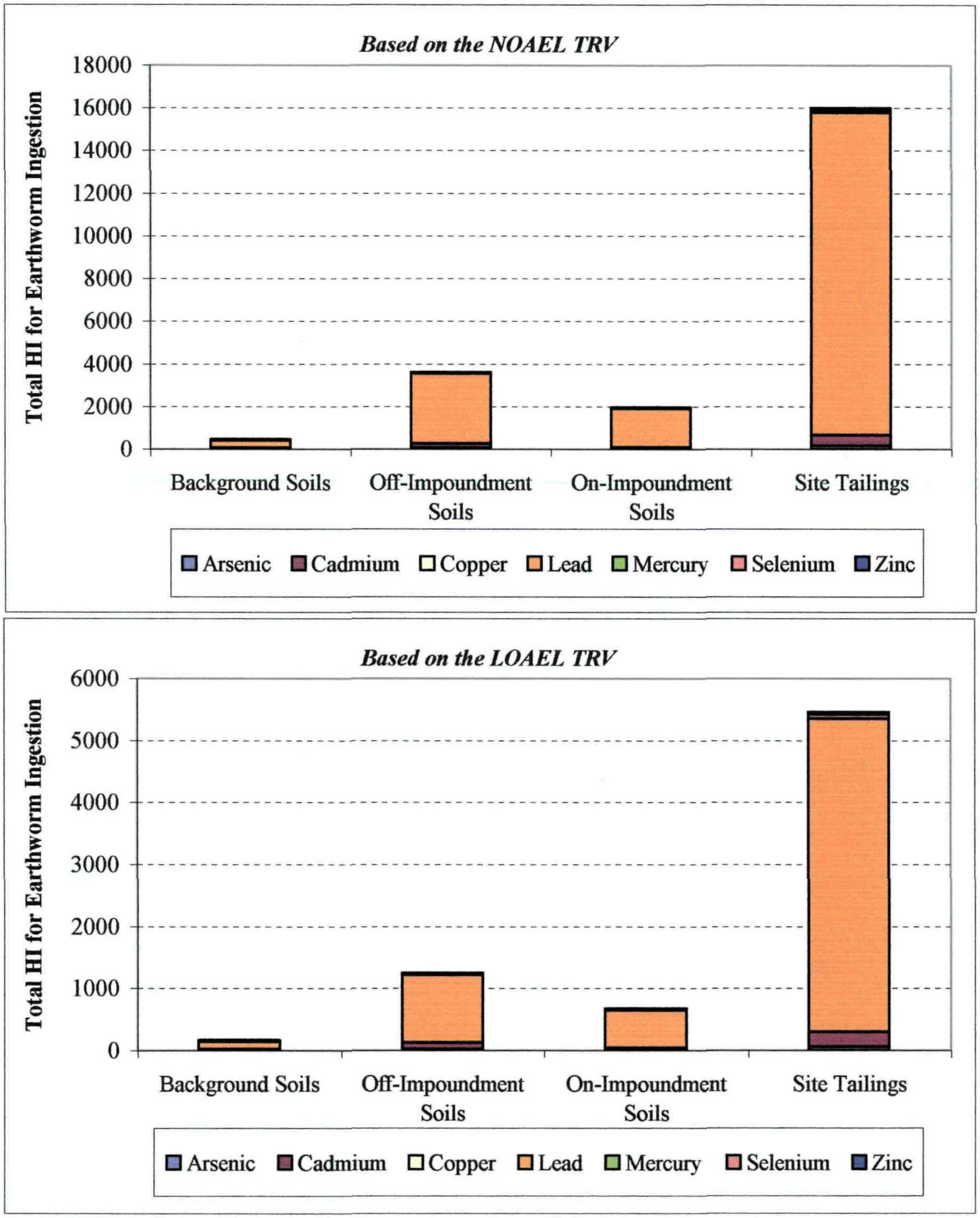


Figure 7-22
Contribution of Each COPC to the Total HI for Ingestion of Small Mammals

Screening Ecological Risk Assessment for Richardson Flat Tailings

American Kestrel

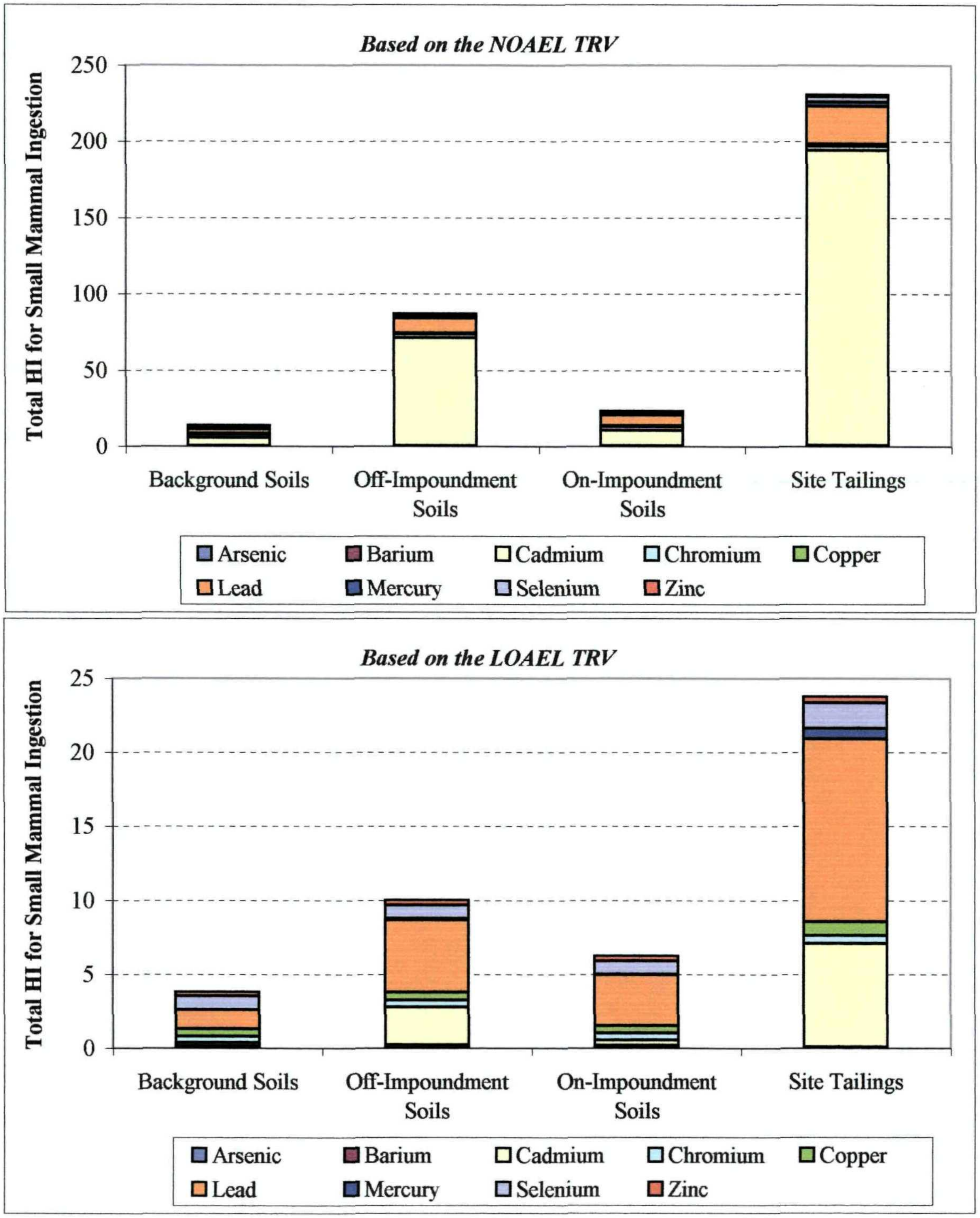


Figure 9-1
Contribution of Each Wildlife Exposure Pathway to the Total HI

Screening Ecological Risk Assessment for Richardson Flat Tailings

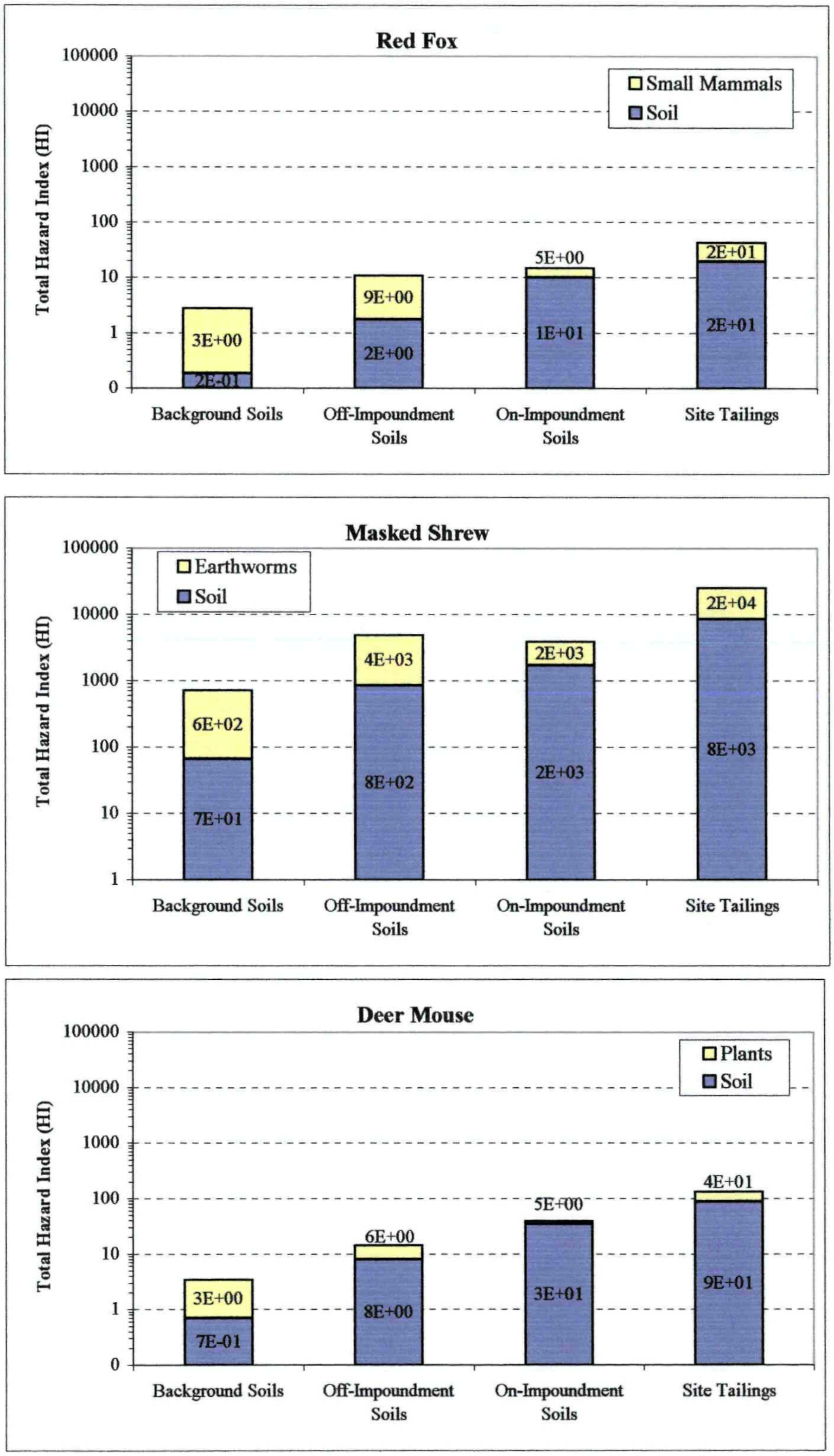
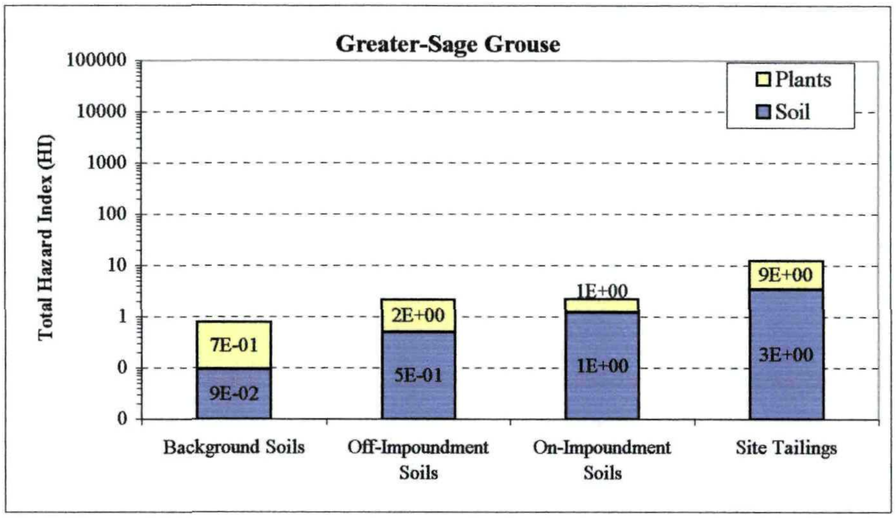
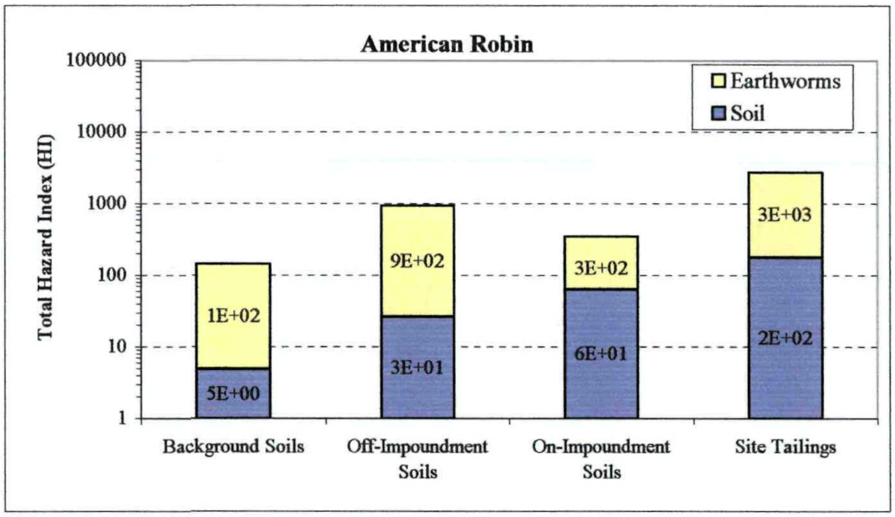


Figure 9-1
Contribution of Each Wildlife Exposure Pathway to the Total HI

Screening Ecological Risk Assessment for Richardson Flat Tailings





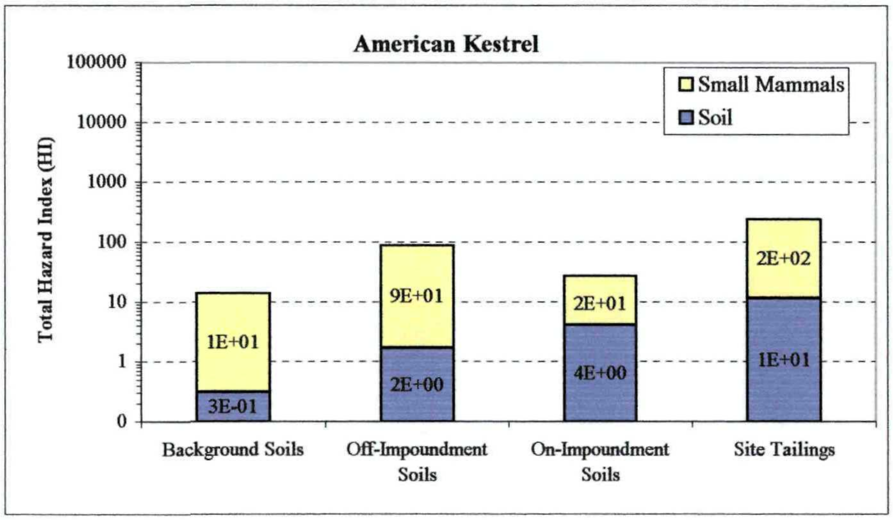
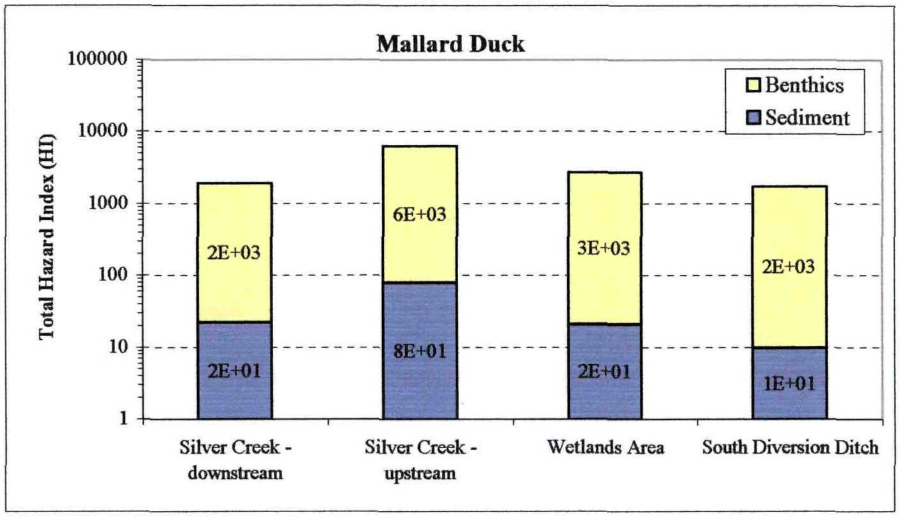
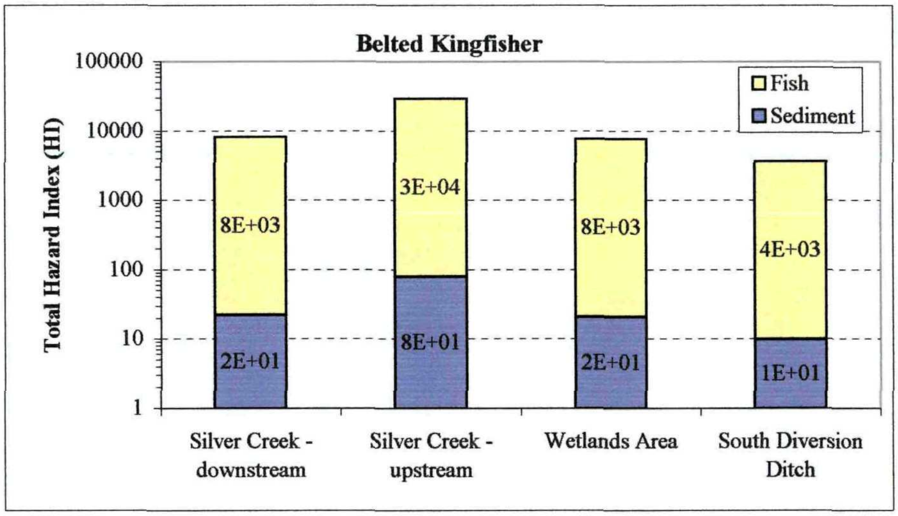


Figure 9-1
Contribution of Each Wildlife Exposure Pathway to the Total HI

Screening Ecological Risk Assessment for Richardson Flat Tailings





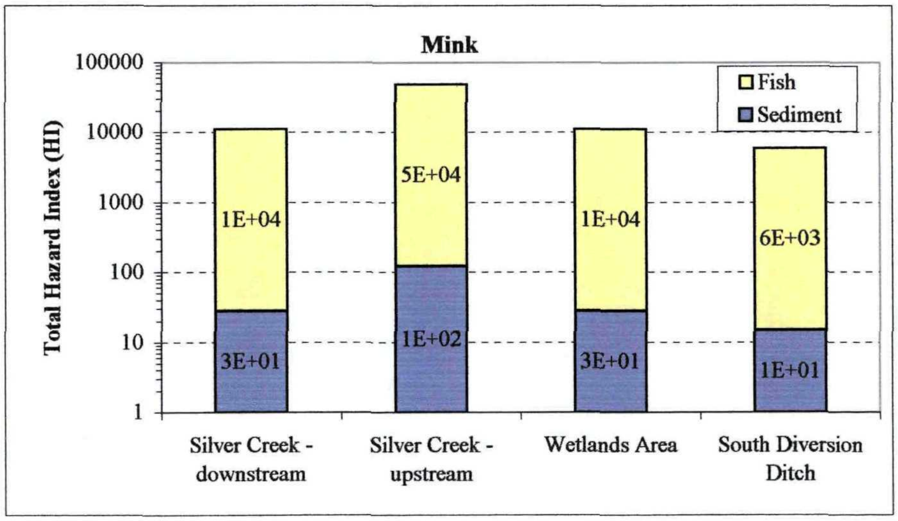


Table 3-1
Summary of Analytical Results for Tailings

Screening Ecological Risk Assessment for Richardson Flat Tailings

Source	Station ID	Depth	Location Description	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Mercury	Selenium	Silver	Zinc
Hazard Ranking System (HRS) (EPA, 1991)	RFT-SS-3	1-3.5 in	Surface tailings; main tailings pile north of diversion ditch (main impoundment)	na	na	311	53	na	225	na	na	na	na	na	na
	RFT-SS-4	3.5-7.5 in		na	na	328	169	na	225	na	4,720	1.97	na	13	23,200
	RFT-SS-5	12.0-17.8 in		na	na	218	61	na	335	na	4,920	2.26	na	26	12,700
	RFT-SS-6	17.8-18.0 in		na	na	34	na	na	105	na	1,090	0.4	na	6.9	1,510
	RFT-TA-1	0-6 in	Easternmost tailings; near edge of diversion ditch	na	na	220	na	na	na	na	na	na	na	na	na
	RFT-TA-2	0-6 in	Near South edge of diversion ditch	na	na	208	na	na	205	na	na	na	na	na	5,710
	RFT-TA-3	0-6 in	Westernmost tailings; near south edge of tailings ditch	na	na	222	95.9	na	336	na	4,520	na	na	22.1	14,100
	RFT-TA-4	0-6 in	Southernmost flood plain tailings	na	na	259	117	na	281	na	9,300	8.2	na	62.8	16,200
	RFT-TA-5	0-6 in	Northernmost flood plain tailings	na	na	175	250	na	265	na	31,600	7.6	na	115	33,800
RMC June 2001 Monthly Report	RF-TA-TP1	2 ft	Tailings from western impoundment area	2,320	41	148	14	8	338	34,600	1,470	0.28	2.5	34	2,110
		3 ft		1,550	18	299	21	2.5	528	77,500	3,920	0.45	2.5	9	4,810
		4 ft		2,880	26	245	46	10	953	62,800	10,200	0.56	2.5	24	7,820
		5 ft		1,960	69	167	32	14	319	52,600	3,010	0.57	11	9	5,930
		6 ft		2,610	120	245	29	10	549	48,000	3,930	0.76	7	19	5,830
		2-6 ft		2,240	30	210	22	7	446	55,900	3,440	0.45	2.5	16	4,320
	RF-TA-TP2	2 ft	Tailings from central impoundment area	2,040	151	257.5	29.5	16	435.5	31,450	3,925	6.25	10.5	34.5	5,755
		3 ft		1,385	209 5	434	29.5	12.5	250	29,300	3,680	4.6	7	29	4,635
		4 ft		1,425	94	177	25.5	14.5	191	37,700	2,495	2.2	9	18	4,685
		5 ft		2,145	165.5	361.5	44	17.5	403	41,000	4,575	5.25	11.5	38	6,730
		6 ft		13,800	249.5	319	80.5	96.5	1070	33,750	12,800	3.05	15	81	13,800
		2-6 ft		3,125	180	304.5	46.5	25	501	34,600	5,575	2.7	11	44	7,540
	RF-TA-TP3	2 ft	Tailings from eastern impoundment area	813	86	211	23	8	163	47,500	2,750	2.3	18	17	3,510
		3 ft		1,100	126	210	26	9	236	34,200	3,330	1.5	11	23	3,670
		4 ft		1,720	216	317	41	14	322	34,600	4,900	3.6	10	37	6,440
		5 ft		2,440	34	199	22	21	242	47,800	3,170	85	0.98	20	6,000
		6 ft		4,080	98	192	59	39	331	47,400	5,230	1.4	13	26	10,300
		2-6 ft		1,770	86	217	32	18	227	45,500	3,400	1.9	15	20	5,270
RMC July 2001 Monthly Report	RF-TSDD-GL50	6 in	Tailings South of Diversion Ditch	3,313	283	459	75	19	692	15,720	9,060	6.3	9	55	14,650
		7 in		2,748	214	313	39	18	497	11,720	7,129	4.8	2.5	44	7,926
		18 in		26,320	2.5	9.7	0.25	28	31	24,270	26	0.05	2.5	2.5	125
		19 in		21,130	2.5	7.9	1.1	25	25	22,940	24	0.05	2.5	2.5	214
	RF-TSDD-GL52	6 in		5,874	505	637	102	30	1208	21,770	21,380	11	20	77	15,480
		18 in		22,180	2.5	6.6	0.25	25	32	22,780	19	0.05	2.5	2.5	157
	RF-TSDD-GL53	8 in		8,373	423	632	113	33	1323	23,200	21,010	21	24	120	18,640
		18 in		23,930	2.5	7.3	0.73	26	34	23,110	57	0.16	2.5	2.5	200
	RF-TSDD-GL56	6 in		2,935	172	264	39	19	467	11,260	5,761	3.6	2.5	38	7,731
		18 in		19,950	6.3	8.6	7.6	24	28	22,080	34	0.05	2.5	2.5	1,306
	RF-TSDD-GL58	14 in		5,365	114	276	44	16	305	72,660	5,122	4.9	20	28	6,520
		20 in		24,210	2.5	12	1.3	26	32	25,200	122	0.29	2.5	2.5	236
	RF-TSDD-GL59	10 in		4,374	334	426	46	19	798	28,080	7,584	26	9.7	43	10,600
		18 in		22,870	2.5	12	1.9	29	39	24,140	85	1.1	2.5	2.5	324
	RF-TSDD-GL62	2.5 in		2,059	88	192	40	12	233	30,740	3,123	1.3	9.2	20	5,865
		3.5 in		32,700	2.5	7.1	0.25	33	20	26,910	21	0.05	2.5	2.5	97

na = not analyzed
All units are in mg/kg.
Concentrations presented are the arithmetic mean at each sampling location.
Non-detects "U" are evaluated at 1/2 the reported detection limit.
Samples designated as 2-6 ft depth are a composite of split samples from each depth increment.

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Table 3-2
Summary of Analytical Results for On-Impoundment Cover Soils
Screening Ecological Risk Assessment for Richardson Flat Tailings

Source	Station ID	Depth	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
E&E, 1993	RF-SO-01	N/A	21,200	2.5	20.9	253	1.1	3	5,850	24.4	13.9	31.4	21,800	111	4,910	1,190	0.055	20.7	4,730	0.305	4.1	136	0.35	41.4	214
	RF-SO-02	N/A	25,300	2.5	3.5	282	1	1.8	5,900	27.9	12.7	24.8	25,600	35	5,200	637	0.055	21.6	4,580	0.61	2	319	0.43	56.3	96
	RF-SO-03*	N/A	2,960	142	357	117	1	83	59,200	12.9	12.6	454	67,300	5,770	10,100	2,020	3.6	18.5	917	25.4	20	209	41.7	13	10,000
	RF-SO-04	N/A	25,800	2.5	5.9	267	1	1.9	5,900	22.2	15	27.2	23,500	125	5,150	899	0.05	18.4	4,330	0.305	2	244	0.59	51.4	127
	RF-SO-05	N/A	22,000	5.7	16.6	317	1.1	5	9,480	24.3	14.5	50.4	27,500	223	4,780	1,030	0.055	21.3	4,540	0.305	2	248	1.9	57.4	432
	RF-SO-06	N/A	25,200	5.6	8.9	197	1.2	2.4	4,920	28.2	10	29.4	23,100	102	5,570	697	0.16	19.9	5,650	0.305	2	159	0.16	42.2	184
RMC June 2001 Monthly Report	RF-ON-1A	0-2 in	na	na	15	na	na	na	na	na	na	na	na	37	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-1B	0-2 in	na	na	9.1	na	na	na	na	na	na	na	na	44	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-1C	0-2 in	na	na	12	na	na	na	na	na	na	na	na	163	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-1D	0-2 in	na	na	10	na	na	na	na	na	na	na	na	96	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-1E	0-2 in	na	na	20	na	na	na	na	na	na	na	na	336	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-1G	0-2 in	na	na	121	na	na	na	na	na	na	na	na	3,239	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-2A	0-2 in	na	na	13	na	na	na	na	na	na	na	na	49	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-2B	0-2 in	na	na	78	na	na	na	na	na	na	na	na	1,155	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-2C	0-2 in	na	na	7.8	na	na	na	na	na	na	na	na	19	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-2D	0-2 in	na	na	6.8	na	na	na	na	na	na	na	na	20	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-2E	0-2 in	na	na	44	na	na	na	na	na	na	na	na	905	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-2F	0-2 in	na	na	82	na	na	na	na	na	na	na	na	2,646	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-2G	0-2 in	na	na	12	na	na	na	na	na	na	na	na	59	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-2H	0-2 in	na	na	2.5	206	na	0.25	na	22.5	na	13.5	na	17	na	na	0.05	na	na	2.5	2.5	na	na	na	63
	RF-ON-2H	6-8 in	22,600	2.5	6	na	na	1	na	22	na	18	24,400	43	na	na	0.05	na	na	2.5	2.5	na	na	na	148
	RF-ON-3A	0-2 in	na	na	49	210	na	6	na	24	na	99	na	875	na	na	0.7	na	na	2.5	2.5	na	na	na	1,010
	RF-ON-3B	0-2 in	na	na	50	na	na	na	na	na	na	na	na	851	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-3B	10-12 in	22,400	2.5	22	na	na	1	na	20	na	53	27,900	206	na	na	0.16	na	na	2.5	2.5	na	na	na	242
	RF-ON-3C	0-2 in	na	na	6.2	na	na	na	na	na	na	na	na	15	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-3D	0-2 in	na	na	46	255	na	3	na	24	na	81	na	515	na	na	0.44	na	na	2.5	2.5	na	na	na	651
	RF-ON-3D	15-17 in	17,600	10	46	na	na	4	na	25	na	88	28,800	634	na	na	1.5	na	na	2.5	2.5	na	na	na	845
	RF-ON-3E	0-2 in	na	na	2.5	360.5	na	0.25	na	20.5	na	19.5	na	15	na	na	0.05	na	na	2.5	3	na	na	na	50
	RF-ON-3E	15-17 in	21,800	2.5	7	na	na	0.25	na	24	na	25	25,100	33	na	na	0.05	na	na	2.5	3	na	na	na	87
	RF-ON-3F	0-2 in	na	na	23	na	na	na	na	na	na	na	na	231	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-3G	0-2 in	na	na	12	na	na	na	na	na	na	na	na	23	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-3H	0-2 in	na	na	7.5	na	na	na	na	na	na	na	na	25	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-3I	0-2 in	na	na	9	187	na	1	na	20	na	25	na	127	na	na	0.05	na	na	2.5	2.5	na	na	na	209
	RF-ON-4A	0-2 in	na	na	81	na	na	na	na	na	na	na	na	1,350	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-4B	0-2 in	na	na	11	na	na	na	na	na	na	na	na	63	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-4C	0-2 in	na	na	12	240	na	1	na	24	na	28	na	83	na	na	0.21	na	na	2.5	2.5	na	na	na	172
	RF-ON-4C	8-10 in	18,900	2.5	13	na	na	4	na	21	na	37	22,100	140	na	na	0.78	na	na	2.5	2.5	na	na	na	273
	RF-ON-4D	0-2 in	na	na	6	327	na	0.25	na	22	na	27	na	18	na	na	0.05	na	na	2.5	2.5	na	na	na	74
	RF-ON-4D	8-10 in	21,600	2.5	7	na	na	0.25	na	23	na	29	29,000	17	na	na	0.05	na	na	2.5	2.5	na	na	na	86
	RF-ON-4E	0-2 in	na	na	7	na	na	na	na	na	na	na	na	20	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-4F	0-2 in	na	na	6	218.5	na	0.25	na	16	na	24	na	21	na	na	0.05	na	na	2.5	3	na	na	na	65
	RF-ON-4F	5-7 in	21,900	2.5	8	na	na	2	na	19	na	26	25,400	47	na	na	0.23	na	na	2.5	3	na	na	na	427

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Table 3-2
Summary of Analytical Results for On-Impoundment Cover Soils
Screening Ecological Risk Assessment for Richardson Flat Tailings

Source	Station ID	Depth	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
RMC June 2001 Monthly Report	RF-ON-4G	0-2 in	na	na	6	na	na	na	na	na	na	na	na	20	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-4G	5-7 in	26,100	2.5	8	na	na	0.25	na	20	na	38	26,300	29	na	na	0.05	na	na	2.5	2.5	na	na	na	100
	RF-ON-4H	0-2 in	na	na	6	na	na	na	na	na	na	na	na	30	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-4H	6-8 in	24,700	2.5	8	na	na	0.25	na	24	na	28	26,800	28	na	na	0.05	na	na	2.5	2.5	na	na	na	115
	RF-ON-4I	0-2 in	na	na	17	na	na	na	na	na	na	na	na	344	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-5A	0-2 in	na	na	13	na	na	na	na	na	na	na	na	42	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-5B	0-2 in	na	na	6	198	na	0.25	na	21	na	25	na	24	na	na	0.05	na	na	2.5	2.5	na	na	na	72
	RF-ON-5B	16-18 in	18,400	2.5	2.5	na	na	0.25	na	20	na	21	19,600	19	na	na	0.05	na	na	2.5	2.5	na	na	na	60
	RF-ON-5C	0-2 in	na	na	15	na	na	na	na	na	na	na	na	159	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-5D	0-2 in	na	na	5	175	na	0.25	na	33	na	26	na	33	na	na	0.05	na	na	2.5	2.5	na	na	na	101
	RF-ON-5D	10-12 in	26,100	2.5	5	na	na	0.25	na	39	na	26	35,800	13	na	na	0.05	na	na	2.5	2.5	na	na	na	74
	RF-ON-5E	0-2 in	na	na	2.5	na	na	na	na	na	na	na	na	15	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-5F	0-2 in	na	na	12	na	na	na	na	na	na	na	na	25	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-5G	0-2 in	na	na	20	na	na	na	na	na	na	na	na	333	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-5H	0-2 in	na	na	9.2	na	na	na	na	na	na	na	na	52	na	na	na	na	na	na	na	na	na	na	na
	RF-ON-6D	0-2 in	na	na	17	na	na	na	na	na	na	na	na	135	na	na	na	na	na	na	na	na	na	na	na

na = not analyzed
All units are in mg/kg
Non-detects "U" are evaluated at 1/2 the reported detection limit
Concentrations presented are the arithmetic mean for each location.
* Not representative of cover soils, sample location at uncovered tailings.

Table 3-3
Summary of Analytical Results for Off-Impoundment Soils

Screening Ecological Risk Assessment for Richardson Flat Tailings

Source	Location Description	Station ID	0-2 inches										1-6 inches									
			Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Selenium	Silver	Zinc	Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Selenium	Silver	Zinc
RMC June 2001 Monthly Report	Transect 1 - North of the RFT Site	RF-OF-T1A	28	na	na	na	na	523	na	na	na	na	24	na	na	na	na	418	na	na	na	na
		RF-OF-T1B	12	na	na	na	na	96	na	na	na	na	10	na	na	na	na	106	na	na	na	na
		RF-OF-T1C	8	199	1	22	23	62	0.05	2.5	2.5	125	9	188	1	21	25	92	0.05	2.5	2.5	165
		RF-OF-T1D	8.2	na	na	na	na	87	na	na	na	na	8.7	na	na	na	na	65	na	na	na	na
		RF-OF-T1E	10.45	na	na	na	na	63.5	na	na	na	na	7.8	na	na	na	na	43	na	na	na	na
		RF-OF-T1F	11	na	na	na	na	79	na	na	na	na	10	na	na	na	na	50	na	na	na	na
		RF-OF-T1G	9.1	na	na	na	na	44	na	na	na	na	9.2	na	na	na	na	49	na	na	na	na
		RF-OF-T1H	10	na	na	na	na	34	na	na	na	na	10	na	na	na	na	31	na	na	na	na
	Transect 2 - South of the RFT Site	RF-OF-T2A	44	na	na	na	na	551	na	na	na	na	30	na	na	na	na	391	na	na	na	na
		RF-OF-T2B	13	na	na	na	na	141	na	na	na	na	13	na	na	na	na	100	na	na	na	na
		RF-OF-T2C	156	na	na	na	na	4,073	na	na	na	na	102	na	na	na	na	2,543	na	na	na	na
		RF-OF-T2D	243	na	na	na	na	5,875	na	na	na	na	316	na	na	na	na	6,265	na	na	na	na
		RF-OF-T2E	238	na	na	na	na	5,364	na	na	na	na	253	na	na	na	na	4,995	na	na	na	na
		RF-OF-T2F	15.5	225.5	1.5	21	39	191.5	0.05	2.5	2.5	273	7	242	0.25	22	21.5	33.5	0.05	2.5	2.5	83.5
		RF-OF-T2G	6.9	na	na	na	na	19	na	na	na	na	8.2	na	na	na	na	20	na	na	na	na
		RF-OF-T2H	9	301	1	31	26	62	0.05	2.5	2.5	107	7	305	0.25	30	22	34	0.05	2.5	2.5	79
		RF-OF-T2I	7.5	na	na	na	na	57	na	na	na	na	7.3	na	na	na	na	36	na	na	na	na
		RF-OF-T2J	7.4	na	na	na	na	21	na	na	na	na	9.6	na	na	na	na	58	na	na	na	na
	Transect 3 - South of the RFT Site	RF-OF-T3A	8.8	na	na	na	na	58	na	na	na	na	9.8	na	na	na	na	52	na	na	na	na
		RF-OF-T3B	47	236	43	21	112	1,070	3.2	2.5	2.5	1,800	27	215	16	20	67	555	3	2.5	2.5	933
		RF-OF-T3C	10	na	na	na	na	78	na	na	na	na	7.2	na	na	na	na	29	na	na	na	na
		RF-OF-T3D	8	396	1	20.5	34.5	69.5	0.11	2.5	2.5	158.5	7	410	1	22	32	37.5	0.05	2.5	2.5	118
		RF-OF-T3E	6.4	na	na	na	na	17	na	na	na	na	7	na	na	na	na	18	na	na	na	na
		RF-OF-T3F	7.8	na	na	na	na	20	na	na	na	na	7.1	na	na	na	na	18	na	na	na	na
		RF-OF-T3G	6.9	na	na	na	na	31	na	na	na	na	6.1	na	na	na	na	24	na	na	na	na
		RF-OF-T3H	7.1	na	na	na	na	27	na	na	na	na	6.8	na	na	na	na	27	na	na	na	na
		RF-OF-T3I	9	na	na	na	na	25	na	na	na	na	9.3	na	na	na	na	25	na	na	na	na
		RF-OF-T3J	7.4	na	na	na	na	28	na	na	na	na	11	na	na	na	na	66	na	na	na	na

Source	Location Description	Station ID	0-2 inches	
			Arsenic	Lead
RMC September 2001 Monthly Report	Study Area Boundary	SAB-1	12	98
		SAB-2	14	135
		SAB-3	11	75
		SAB-4	12	144
		SAB-5	12	53
		SAB-6*	167	3,625
		SAB-7	30	165
		SAB-8	23	63

na = not analyzed

All units are in mg/kg.

Non-detects "U" are evaluated at 1/2 the reported detection limit.

Concentrations presented are the arithmetic mean for each location.

* This sample respresents tailings and was excluded from the off-impoundment soils dataset.

Table 3-4
Summary of Analytical Results for Background Soils

Screening Ecological Risk Assessment for Richardson Flat Tailings

Source	Station ID	Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Selenium	Silver	Zinc
RMC June 2001 Monthly Report	RF-BG-BG1	11	na	na	na	na	47	na	na	na	na
	RF-BG-BG2	8.1	na	na	na	na	26	na	na	na	na
	RF-BG-BG3	8.6	na	na	na	na	22	na	na	na	na
	RF-BG-BG4	9.2	na	na	na	na	25	na	na	na	na
	RF-BG-BG5	11	na	na	na	na	43	na	na	na	na
	RF-BG-BG6	7.0	na	na	na	na	30	na	na	na	na
	RF-BG-BG7	6.9	na	na	na	na	25	na	na	na	na
	RF-BG-BG8	14	265	1.0	20	29	84	0.2	2.5	2.5	127
	RF-BG-BG9	6.7	na	na	na	na	98	na	na	na	na
	RF-BG-BG10	7.0	220	0.25	22.5	15.5	30.5	0.1	2.5	2.5	93
	RF-BG-BG11*	282	na	na	na	na	7,731	na	na	na	na

na = not analyzed
All units are in mg/kg.
Non-detects "U" are evaluated at 1/2 the reported detection limit.
All samples were collected at a depth of 0-2 inches.
For BG10, concentrations presented are the arithmetic mean of the field and duplicate samples.
* This sample was collected near tailings and was excluded as a background soil.

Table 3-5
Summary of Analytical Results for Surface Water Collected by E&E (1993)

Screening Ecological Risk Assessment for Richardson Flat Tailings

Station ID	Location Description	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium (mg/L)	Chromium	Cobalt	Copper	Iron	Lead	Magnesium (mg/L)	Manganese	Mercury	Nickel	Potassium (mg/L)	Selenium	Silver	Sodium (mg/L)	Thallium	Vanadium	Zinc
RF-SW-01	Silver Creek upstream of south diversion ditch	20.3	36.7	4.2	49.2	3.4	3.9	233	3.9	3	10	193	35.3	39	249	0.1	5.55	3.5	7.5	1.2	64	0.8	17.85	1,110
RF-SW-02		70.1	24.8	5.2	54.6	2.8	1.65	157	3.9	3	10	158	18.8	37	495	0.1	25.4	2.1	7.5	1.2	25	0.8	17.85	2,080
RF-SW-03		19.3	24.3	7.3	50.5	2.1	1.65	128	3.9	3	10	307	15	31	458	0.1	5.55	1.6	7.5	1.2	21	0.8	17.85	769
RF-SW-04		65.5	38.7	7.6	54.4	2.1	3.5	149	3.9	10.4	10	356	36.4	34	438	0.1	5.55	2.0	7.5	1.2	26	0.8	17.85	776
RF-SW-05	Silver Creek downstream of south diversion ditch	8.55	12.15	7.2	65.6	2.4	1.65	163	3.9	3	10	279	151	37	269	0.1	5.55	1.3	7.5	1.2	26	0.8	17.85	466
RF-SW-06		185	30.1	12.5	66	0.93	1.65	146	3.9	3	10	446	33.2	38	399	0.1	5.55	1.4	7.5	10	28	0.8	17.85	321
RF-SW-07	South Diversion Ditch	36.7	12.15	5.7	32.7	3.2	1.65	341	3.9	3	10	703	33.3	61	9,230	0.24	12.8	3.2	7.5	5	51	0.8	17.85	64.2
RF-SW-08		319	12.15	11.4	54.3	1	1.65	190	3.9	3	20	1,320	146	38	1,590	0.1	20.9	1.2	7.5	5	30	0.8	17.85	745

All units are in ug/L unless specified.
Concentrations presented are the arithmetic mean at each station.
Assumed to represent total recoverable concentrations.
Non-detects "U" are evaluated at 1/2 the reported detection limit.

Table 3-6
Summary of Analytical Results for Surface Water Collected by USEPA (2001) for the Silver Creek Watershed

Screening Ecological Risk Assessment for Richardson Flat Tailings

INORGANICS

General Location	Station ID	Location Description	Analysis Type	Aluminum	Antimony	Arsenic	Cadmium	Calcium (mg/L)	Chromium	Copper	Iron	Lead	Magnesium (mg/L)	Manganese	Mercury	Potassium (mg/L)	Selenium	Silver	Sodium (mg/L)	Zinc
Silver Creek - upstream	USC-7	Silver Creek above Silver Maple Claims	Dissolved	25	3.3	3.1	2.6	na	4.4	5.8	92	2.3	na	315	0.004	na	2.5	2.1	na	765
	USC-6	Silver Creek below Silver Maple Claims		25	11	5.9	2.0	na	5.0	2.5	50	2.5	na	465	0.003	na	2.5	2.5	na	788
	USC-5	Silver Creek above Richardson Flats; at old north road to site		25	7.0	3.8	1.8	na	5.0	4.8	85	2.5	na	410	na	na	2.5	2.5	na	1,475
	USC-3	Silver Creek at Richardson Flats; upstream of RR tressel		73	6.3	6.3	1.5	na	5.0	2.5	50	2.5	na	197	na	na	2.5	2.5	na	710
South Diversion Ditch	USC-4	Richardson Flats diversion ditch 50'		25	2.5	2.5	1.8	na	15	2.5	50	2.5	na	2,393	0.001	na	2.5	2.5	na	55
Silver Creek - downstream	USC-2	Silver Creek below Richardson Flat; at U248 culvert		25	5.5	4.8	1.5	na	5.0	2.5	190	7.3	na	210	na	na	2.5	2.5	na	520
	USC-1	Silver Creek below Richardson Flat; at U248 rail tressel		25	7.0	4.5	1.8	na	5.0	2.5	50	2.5	na	393	0.002	na	2.5	2.5	na	710
Silver Creek - upstream	USC-7	Silver Creek above Silver Maple Claims	Total Recoverable	5,672	25	32	12	106	18	169	9,986	669	23	336	0.28	3.0	10	12	139	2,140
	USC-6	Silver Creek below Silver Maple Claims		1,369	196	406	49	149	8	616	44,818	9,250	26	465	0.46	3.7	11	38	142	10,615
	USC-5	Silver Creek above Richardson Flats; at old north road to site		6,145	68	150	24	135	16	489	29,588	4,257	31	440	0.45	1.8	6.5	18	96	5,474
	USC-3	Silver Creek at Richardson Flats; upstream of RR tressel		40	7.3	6.7	2.8	125	5.0	4.0	240	31	35	207	na	1.0	2.5	2.5	51	787
South Diversion Ditch	USC-4	Richardson Flats diversion ditch 50'		25	2.5	3.7	1.8	298	5.0	3.7	50	5	62	2,273	0.00	1.8	2.5	2.5	48	82
Silver Creek - downstream	USC-2	Silver Creek below Richardson Flat; at U248 culvert		5,146	62	113	25	142	17	256	21,565	2,955	38	200	0.22	1.8	5.0	21	49	4,933
	USC-1	Silver Creek below Richardson Flat; at U248 rail tressel		4,341	57	137	17	146	13	279	26,638	3,439	38	403	0.18	1.8	5.9	17	56	4,159

na = not analyzed
Concentrations presented are the arithmetic mean at each station.
All units are in ug/L, unless otherwise noted.
Non-detects "U" are evaluated at 1/2 the reported detection limit.

Table 3-7
Summary of Analytical Results for Surface Water Collected by UPCM

Screening Ecological Risk Assessment for Richardson Flat Tailings

Station ID	Location Description	Analysis Type	Parameter	Mean Conc	Conc Range (Min-Max)	Sampling Date Range*
N4	Silver Creek upstream of diversion ditch	Dissolved	Lead	20	na	06-May-87
			Zinc	560	na	06-May-87
		Total	Copper	126	4 - 390	27-Jun-96 to 25-Sep-98
			Cyanide	4.2	2 - 54	29-Apr-82 to 09-Sep-87
			Lead	744	5 - 26,000	29-Apr-82 to 25-Sep-98
			Manganese	284	27 - 1,300	29-Apr-82 to 25-Sep-98
			Mercury	64	0.1 - 2,000	29-Apr-82 to 25-Sep-98
			Zinc	1059	280 - 2,800	06-May-87 to 25-Sep-98
		Water Quality	TDS (mg/L)	631	260 - 1,053	29-Apr-82 to 09-Sep-87
			TSS (mg/L)	4	na	06-May-87
N5	Diversion Ditch	Dissolved	Lead	8.5	na	06-May-87
			Zinc	760	na	06-May-87
		Total	Copper	6.2	4 - 13	27-Jun-96 to 25-Sep-98
			Cyanide	4.5	2 - 34	29-Apr-82 to 09-Sep-87
			Lead	43	5 - 100	29-Apr-82 to 25-Sep-98
			Manganese	3,004	45 - 61,000	29-Apr-82 to 25-Sep-98
			Mercury	2.2	0.1 - 2.5	29-Apr-82 to 25-Sep-98
			Zinc	394	36 - 1,200	06-May-87 to 25-Sep-98
		Water Quality	TDS (mg/L)	1,404	566 - 2,016	29-Apr-82 to 09-Sep-87
			TSS (mg/L)	2	na	06-May-87
N6	Silver Creek downstream of diversion ditch	Dissolved	Lead	25	na	06-May-87
			Zinc	370	na	06-May-87
		Total	Copper	6.0	4 - 11	27-Jun-96 to 25-Sep-98
			Cyanide	2.4	2 - 7	29-Apr-82 to 09-Sep-87
			Lead	107	5 - 1,000	29-Apr-82 to 25-Sep-98
			Manganese	301	57 - 930	29-Apr-82 to 25-Sep-98
			Mercury	51	0.1 - 2,100	29-Apr-82 to 25-Sep-98
			Zinc	759	330 - 1,600	06-May-87 to 25-Sep-98
		Water Quality	TDS (mg/L)	742	629 - 915	03-Sep-86 to 09-Sep-87
			TSS (mg/L)	4	na	06-May-87

*Although UPCM has conducted sampling since 1975, pre-1982 data were not available for review at the time of the SERA.
All units are in ug/L, unless otherwise noted.
na = not applicable (only one date sampled)
Non-detects "U" are evaluated at 1/2 the reported detection limit.

DRAFT

Table 3-8
Summary of Analytical Results for Surface Water Collected by RMC

Screening Ecological Risk Assessment for Richardson Flat Tailings

INORGANICS

General Location	Station ID	Analysis Type	Aluminum	Antimony	Arsenic	Barium	Cadmium	Calcium (mg/L)	Chromium	Copper	Cyanide	Iron	Lead	Magnesium (mg/L)	Manganese	Mercury	Potassium (mg/L)	Selenium	Silver	Sodium (mg/L)	Zinc
Silver Creek - upstream	RF-7	Dissolved	25	8.0	7.4	74	2.2	na	7.5	4.2	na	50	2.5	na	400	0.25	na	2.5	4.4	na	28,403
	RF-7-2		51	6.2	6.1	93	2.0	145	6.6	5.0	na	58	3.5	40	442	0.13	na	2.3	3.8	na	922
Silver Creek - downstream	RF-8		33	6.6	6.0	88	1.4	324	7.3	4.1	na	135	3.6	70	986	0.09	na	2.4	3.9	na	585
	RF-8-2		na	na	10.0	180	2.0	na	10.0	5.0	na	na	2.5	na	na	0.25	na	2.5	5.0	na	850
South Diversion Ditch	RF-2		108	6.3	7.1	170	0.5	na	7.5	7.8	na	125	3.1	na	20	0.20	na	2.3	3.8	na	49
	RF-4		35	2.5	4.5	94	0.5	na	6.1	5.4	na	44	2.9	na	216	0.13	na	2.2	3.3	na	794
	RF-5		31	3.1	4.3	79	0.5	na	6.0	5.2	na	41	2.5	na	242	0.12	na	2.2	3.5	na	325
	RF-5-4		47	2.5	4.8	na	0.5	na	5.0	9.8	na	50	2.5	na	345	0.16	na	2.0	2.5	na	1,550
	RF-6		na	na	6.5	81	0.9	157	7.7	5.0	na	38	2.5	43	2816	0.25	na	2.6	4.4	na	249
	RF-6-2		33	2.5	3.9	210	0.6	na	6.8	4.6	na	65	2.9	na	4222	0.06	na	2.1	3.4	na	57
Ponded Water	RF-9		na	na	10.0	130	0.5	na	10.0	5.0	na	na	2.5	na	na	0.25	na	2.5	5.0	na	29
Unnamed Drainages - Background	RF-10		na	na	10.0	250	0.5	na	10.0	5.0	na	na	9.0	na	na	0.25	na	2.5	5.0	na	9
	RF-1		298	2.5	6.3	150	0.5	na	7.5	7.8	na	240	3.6	na	3	0.14	na	2.3	3.8	na	36
	RF-3		na	na	10.0	160	0.5	na	10.0	5.0	na	na	2.5	na	na	0.25	na	2.5	5.0	na	24
	RF-3-2		46	6.7	7.2	na	0.3	na	5.0	9.5	na	50	3.3	na	19	0.14	na	2.0	2.5	na	42
Silver Creek - upstream	RF-7	Total Recoverable	25	11.0	8.1	78	3.2	122	7.5	8.0	na	15,195	56.0	35	390	0.25	2.3	2.5	4.4	71	32,807
	RF-7-2		65	9.5	7.4	99	3.3	131	6.1	5.9	2	341	29.6	34	378	0.19	2.5	3.2	7.4	58	1,011
Silver Creek - downstream	RF-8		81	8.4	8.5	93	2.3	134	6.3	7.0	2	531	40.2	36	977	0.16	2.6	2.4	4.1	55	740
	RF-8-2		na	na	10.0	170	3.0	102	10.0	5.0	na	na	28.0	na	na	0.25	2.0	2.5	5.0	76	850
South Diversion Ditch	RF-2		370	4.3	6.9	180	0.5	56	7.5	8.5	na	370	4.2	13	26	0.22	2.7	2.3	3.8	31	54
	RF-4		106	2.5	4.6	76	0.9	145	5.0	6.5	na	87	2.5	32	232	0.21	1.5	2.2	3.3	27	862
	RF-5		73	3.6	4.1	82	0.5	221	5.5	6.2	na	159	2.9	51	272	0.18	1.6	2.0	5.8	33	403
	RF-5-4		261	4.3	5.3	na	1.5	133	5.0	10.3	na	305	2.5	29	345	0.17	1.8	2.0	2.5	37	1,630
	RF-6		na	na	6.2	88	1.1	250	11.6	5.0	2	281	16.0	59	3222	0.23	2.0	3.0	4.4	44	333
	RF-6-2		83	3.3	71.5	220	0.6	277	6.4	5.9	na	174	4.1	61	4049	0.09	2.7	3.4	3.7	46	131
Ponded Water	RF-9		na	na	10.0	140	0.5	82	10.0	5.0	na	na	2.5	20	na	0.25	6.2	2.5	5.0	177	11
Unnamed Drainages - Background	RF-10		na	na	21.0	260	0.5	60	10.0	5.0	na	na	23.0	17	na	0.25	2.0	2.5	5.0	47	69
	RF-1		939	2.5	6.3	160	0.5	37	7.5	7.5	na	625	3.1	9	10	0.14	1.7	2.3	3.8	16	38
	RF-3		na	na	10.0	170	0.5	56	10.0	5.0	na	na	2.5	14	na	0.25	2.0	2.5	5.0	32	17
	RF-3-2		483	4.8	8.7	na	0.3	29	3.3	10.2	na	300	4.8	7	23	0.15	2.6	2.0	2.5	53	53

na = not analyzed
Concentrations presented are the arithmetic mean at each station.
All units are in ug/L, unless otherwise noted.
Non-detects "U" are evaluated at 1/2 the reported detection limit.

Table 3-9
Summary of Analytical Results for Sediments
Screening Ecological Risk Assessment for Richardson Flat Tailings

Source	Station ID	Station Location	Depth	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
E&E, 1993	RF-SE-01	South Diversion Ditch Wetlands	N/A	28,550	97.85	165	283.5	2.25	84.35	45,300	60.05	16.7	648	37,100	6,365	14,100	4,080	7.05	50.65	4,760	12.2	34.75	513.5	7.45	68	13,950
	RF-SE-02		N/A	1,930	85.4	189	92.1	1.2	52.8	56,300	15.8	5.8	183	31,100	3,010	13,800	2,200	2.7	37.75	886	11.4	10.7	206	13.6	9.5	8,160
	RF-SE-03		N/A	4,530	99	310	157	1.1	64.9	51,000	14.9	19.3	313	91,900	5,220	11,900	2,330	2.4	na	1120	43.1	16.3	634	7.8	17.8	11,200
	RF-SE-04		N/A	11,800	40.1	189	562	2.3	40.3	96,000	25	10.4	190	64,400	2,350	10,900	42,000	1.3	na	2710	12	8	1150	6.6	28.4	5,400
Silver Creek Watershed Sampling 2000 (USEPA, 2001)	USC-1	Silver Creek below Richardson Flat; at U248 rail tressel	0-12 inches	11,250	122	332	na	na	29	na	30	na	602	65,540	5,960	na	na	0.44	na	na	11	28	na	na	na	6,796
			surface	9,969	140	341	na	na	50	na	21	na	766	66,340	11,130	na	na	0.11	na	na	11	49	na	na	na	11,730
	USC-2	Silver Creek below Richardson Flat: at U248 culvert	0-12 inches	11,590	137	271	na	na	58	na	32	na	588	55,160	6,942	na	na	0.25	na	na	10	40	na	na	na	11,950
			surface	8,943	97	177	na	na	37	na	26	na	430	30,900	4,861	na	na	0.18	na	na	5	35	na	na	na	6,780
	USC-5	Silver Creek above Richardson Flats: at old north road to site	0-12 inches	15,220	76	203	na	na	19	na	31	na	563	47,710	5,794	na	na	0.41	na	na	5	19	na	na	na	6,624
			surface	9,308	175	393	na	na	65	na	22	na	1380	69,730	11,190	na	na	0.49	na	na	16	48	na	na	na	12,270
	USC-6	Silver Creek below Silver Maple Claims	0-12 inches	3,181	889	1735	na	na	179	na	12	na	2559	110,700	42,990	na	na	1.6	na	na	26	136	na	na	na	44,560
			surface	4,930	232	669	na	na	104	na	15	na	1115	156,800	12,440	na	na	0.18	na	na	32	81	na	na	na	15,880
	USC-7	Silver Creek above Silver Maple Claims	0-12 inches	14,720	64	105	na	na	28	na	42	na	450	27,170	2,656	na	na	0.83	na	na	5	20	na	na	na	4,619
			surface	12,630	39	54.5	na	na	20.5	na	34.55	na	349.8	20,560	981	na	na	0.25	na	na	24.75	27.165	na	na	na	3,281
RMC June 2001 Monthly Report	RF-SD-SD1	South Diversion Ditch	0-6 inches	4,850	72	156	na	na	73	na	18	na	280	39,900	3,490	na	na	1.6	22.5	na	8	25	na	na	na	12,000
	RF-SD-SD2		0-6 inches	6,450	53	119	na	na	50	na	16	na	200	32,600	2,330	na	na	0.77	51.5	na	2.5	16	na	na	na	8,780
	RF-SD-SD3		0-6 inches	10,500	36	125	na	na	35	na	21	na	173	28,600	1,880	na	na	0.32	12.05	na	2.5	13	na	na	na	6,800
	RF-SD-SD4		0-6 inches	7,480	65	205	na	na	51	na	18	na	260	33,200	2,840	na	na	1.2	18	na	6	19	na	na	na	9,140
	RF-SD-SD5		0-6 inches	8,445	95	111.5	na	na	38	na	18	na	254.5	23,050	2,655	na	na	0.975	27.25	na	3.75	20	na	na	na	7,510
	RF-SD-SD6		0-6 inches	20,600	63	101	na	na	18	na	30	na	211	27,000	2,280	na	na	1.5	1.325	na	2.5	14	na	na	na	2,940

N A = not available

na = not analyzed

All units are in mg kg.

Non-detects "U" are evaluated at 1 2 the reported detection limit.

Concentrations presented are the arithmetic mean at each sampling location.

Table 3-10
Summary of Analytical Results for Groundwater Monitoring Wells

Screening Ecological Risk Assessment for Richardson Flat Tailings

Analysis Type	Station Location	Monitoring wells below main embankment					Upgradient monitoring well
	Station ID	MW-01	MW-03	MW-04	MW-05	MW-06	RT-1
	Sampling Dates	*4/29/82 to 9/25/98*	*4/29/82 to 9/25/98*	*6/1/82 to 9/25/98*	*6/1/82 to 9/25/98*	*4/29/82 to 9/25/98*	*9/1/85 to 8/1/92*
Dissolved	Aluminum	15 - 49.6	na	na	na	15 - 68.5	15 - 191
	Antimony	2.5 - 40.5	na	na	na	2.5 - 35.9	2.5 - 33.2
	Arsenic	2.5 - 3.6	na	na	na	8.8 - 9	2.5 - 3.6
	Barium	64 - 104	na	na	na	46.2 - 99	76 - 93.9
	Beryllium	1.8 - 5	na	na	na	3.7 - 5	0.9 - 5
	Cadmium	2.5 - 3.3	na	na	na	2.5 - 3.3	2.5 - 3.3
	Calcium	254 - 196,000	na	na	na	307 - 365,000	47 - 43,500
	Chromium	2.5 - 7.8	na	na	na	2.5 - 7.8	2.5 - 7.8
	Cobalt	6 - 10	na	na	na	6 - 67	2.5 - 6
	Copper	2.5 - 20	na	na	na	2.5 - 20	2.5 - 171
	Cyanide	na	na	na	na	na	na
	Iron	62.6 - 376	na	na	na	2170 - 14,800	5 - 151
	Lead	2.2 - 570	5 - 62	5 - 110	5 - 140	2.2 - 56	15 - 40.9
	Magnesium	56 - 41,800	na	na	na	70 - 55,000	8.8 - 908
	Manganese	10 - 33,000	720 - 7,700	2,000 - 11,000	700 - 15,000	490 - 9,990	11 - 19.5
	Mercury	0.05 - 0.2	na	na	na	0.05 - 0.2	0.05 - 0.2
	Nickel	15 - 24.9	na	na	na	15 - 28.9	11.1 - 15
	Potassium	5,530 - 5,530	na	na	na	3010 - 3010	1360 - 1,360
	Selenium	2.5 - 15	na	na	na	2.5 - 15	2.5 - 3
	Silver	2.5 - 10	na	na	na	2.5 - 10	2.5 - 10
	Sodium	42 - 35,700	na	na	na	52 - 49700	16 - 16,800
	Thallium	1.6 - 50	na	na	na	1.6 - 50	1.6 - 50
	Vanadium	5 - 35.7	na	na	na	5 - 35.7	5 - 35.7
	Zinc	2.5 - 250	17 - 170	30 - 470	4 - 1,900	4 - 210	6 - 20.1
Total Recoverable	Aluminum	2690 - 80,700	na	na	na	1,630 - 4,920	1,040 - 15,700
	Antimony	2.5 - 24.3	na	na	na	28.4 - 63	2.5 - 24.36
	Arsenic	5.2 - 76	na	na	na	11.3 - 349	2.5 - 3.7
	Barium	99.6 - 1,534	na	na	na	58.3 - 2665	83 - 196
	Beryllium	3.4 - 3.4	na	na	na	4.9 - 5	1.3 - 5
	Cadmium	3.3 - 42	na	na	na	3.3 - 16	2.5 - 3.3
	Calcium	352 - 191,000	na	na	na	314 - 318,000	45 - 42,200
	Chromium	7.8 - 95	na	na	na	7.8 - 42	2.5 - 10.5
	Cobalt	7.5 - 46	na	na	na	9 - 80	2.5 - 11
	Copper	4 - 1583	4 - 12	4 - 15	4 - 15	4 - 190	2.5 - 30
	Cyanide	2 - 280	0.4 - 25	4 - 99,000	0 - 350	2 - 4,600	5 - 5
	Iron	3,180 - 126,000	na	na	na	3,190 - 26,300	955 - 14,100
	Lead	15.6 - 588	17 - 120	17 - 400	17 - 430	8.5 - 1,080	15 - 627
	Magnesium	88 - 44,200	na	na	na	72 - 52,500	909 - 12,200
	Manganese	17 - 2,230	370 - 6,600	230 - 12,000	270 - 16,000	130 - 10,400	20 - 162
	Mercury	0.1 - 0.7	0.1 - 2.5	0.1 - 2.5	0.1 - 2.5	0.1 - 2.5	0.05 - 0.2
	Nickel	11.1 - 88	na	na	na	25.6 - 30	13 - 15
	Potassium	6,060 - 6,060	na	na	na	3,290 - 3,290	1,390 - 1,390
	Selenium	2.5 - 15	na	na	na	2.5 - 15	2.5 - 3
	Silver	2.4 - 2.5	na	na	na	3.3 - 17	2.4 - 2.5
	Sodium	44 - 38,100	na	na	na	54 - 486	16 - 16,100
	Thallium	1.6 - 50	na	na	na	1.6 - 50	1.6 - 50
	Vanadium	35.7 - 262	na	na	na	17 - 35.7	5 - 35.7
	Zinc	99.5 - 650	na	na	na	92.5 - 2,790	2.5 - 136

na = not available
Range presented is the minimum to the maximum.
Non-detects are evaluated at 1/2 the detection limit.
All units are in ug/L.

Table 3-11
Summary of Analytical Parameters Across Media Types and Sampling Programs

Screening Ecological Risk Assessment for Richardson Flat Tailings

Analytes	Tailings	Soil			Sediment	Groundwater		Surface Water	
		Background	Off-Impoundment	On-Impoundment		Dissolved	Total	Dissolved	Total
Aluminum	2	**NONE**	**NONE**	2; 3	1; 2; 3	2; 3; 7	2; 3; 7	1; 2; 5; 6	1; 3; 2; 5; 6
Antimony	2	**NONE**	**NONE**	2; 3	1; 2; 3	2; 3; 7	2; 3; 7	1; 2; 6	1; 3; 2; 6
Arsenic	2; 4	2	2	2; 3	1; 2; 3	2; 3; 7	2; 3; 7	1; 2; 5; 6; 7	1; 2; 3; 5; 6; 7
Barium	**NONE**	2	2	2; 3	3	3; 7	3; 7	5; 6; 7	3; 5; 7
Beryllium	**NONE**	**NONE**	**NONE**	3	3	3; 7	3; 7	**NONE**	3
Boron	**NONE**	**NONE**	**NONE**	**NONE**	**NONE**	**NONE**	**NONE**	5	**NONE**
Cadmium	2; 4	2	2	2; 3	1; 2; 3	2; 3; 7	2; 3; 7	1; 2; 5; 6; 7	1; 2; 3; 5; 6; 7
Calcium	**NONE**	**NONE**	**NONE**	3	3	3; 7	2; 3; 7	5; 6	1; 2; 3; 6
Chromium	2	2	2	2; 3	1; 2; 3	2; 3; 7	2; 3; 7	1; 2; 5; 6; 7	1; 2; 3; 5; 6; 7
Cobalt	**NONE**	**NONE**	**NONE**	3	3	3; 7	3; 7;	**NONE**	3
Copper	2; 4	2	2	2; 3	1; 2; 3	2; 3; 7	2; 3; 7	1; 2; 5; 6; 7	1; 2; 3; 5; 6; 7
Cyanide	**NONE**	**NONE**	**NONE**	**NONE**	**NONE**	**NONE**	7	**NONE**	5; 6
Iron	2	**NONE**	**NONE**	2; 3	1; 2; 3	2; 3; 7	2; 3; 7	1; 2; 5; 6	1; 2; 3; 5; 6
Lead	2; 4	2	2	2; 3	1; 2; 3	2; 3; 7	2; 3; 7	1; 2; 5; 6; 7	1; 2; 3; 5; 6; 7
Magnesium	**NONE**	**NONE**	**NONE**	3	3	3; 7	2; 3; 7	5; 6	1; 2; 3; 6
Manganese	**NONE**	**NONE**	**NONE**	3	3	2; 3; 7	2; 3; 7	1; 2; 5; 6	1; 2; 3; 5; 6
Mercury	2; 4	2	2	2; 3	1; 2; 3	2; 3; 7	2; 3; 7	1; 2; 5; 6; 7	1; 2; 3; 5; 6; 7
Nickel	**NONE**	**NONE**	**NONE**	3	3	3; 7	3; 7	**NONE**	3
Phosphorus	**NONE**	**NONE**	**NONE**	**NONE**	**NONE**	**NONE**	2	5	2; 5
Potassium	**NONE**	**NONE**	**NONE**	3	3	3; 7	2; 3; 7	5	1; 2; 3; 6
Selenium	2	2	2	2; 3	1; 2; 3	2; 3; 7	2; 3; 7	1; 2; 5; 6; 7	1; 2; 3; 5; 6; 7
Silver	2; 4	2	2	2; 3	1; 2; 3	2; 3; 7	2; 3; 7	1; 2; 5; 6; 7	1; 2; 3; 5; 6; 7
Sodium	**NONE**	**NONE**	**NONE**	3	3	2; 3; 7	2; 3; 7	5	1; 2; 3; 6
Thallium	**NONE**	**NONE**	**NONE**	3	3	3; 7	3; 7	**NONE**	3
Vanadium	**NONE**	**NONE**	**NONE**	3	3	3; 7	3; 7	**NONE**	3
Zinc	2; 4	2	2	2; 3	1; 2; 3	2; 3; 7	2; 3; 7	1; 2; 5; 6; 7	1; 3; 5; 6; 7

Key to Sources

1 = USEPA (2001a) Watershed Study
2 = RMC (2001c) Monthly Monitoring Data
3 = E&E (1993)
4 = USEPA (1991)
5 = STORET
6 = UPCM
7 = RMC (2000a)

Table 4-1
Summary of Soil Cover Thickness for On-Impoundment Soils

Screening Ecological Risk Assessment for Richardson Flat Tailings

Sample ID	Soil Cover Thickness
RF-ON-1A	*No Tailings*
RF-ON-1B	*No Tailings*
RF-ON-1C	15 inches (mixed tailings below)
RF-ON-1D	15.6 inches
RF-ON-1E	7.2 inches
RF-ON-1G	14.4 inches
RF-ON-2A	*No Tailings*
RF-ON-2B	*No Tailings*
RF-ON-2C	18 inches
RF-ON-2D	18 inches
RF-ON-2E	15 inches
RF-ON-2F	48 inches
RF-ON-2G	*No Tailings [cover soil to 11 feet]*
RF-ON-3A	*No Tailings*
RF-ON-3B	12 inches
RF-ON-3C	10.8 inches
RF-ON-3D	19.2 inches
RF-ON-3E	24 inches
RF-ON-3F	13.2 inches
RF-ON-3G	30 inches
RF-ON-3H	6 inches
RF-ON-3I	*No Tailings [cover soil to 18 inches]*
RF-ON-4A	3 inches
RF-ON-4B	7.9 inches
RF-ON-4C	9.6 inches
RF-ON-4D	9.6 inches
RF-ON-4E	12 inches
RF-ON-4F	8.4 inches
RF-ON-4G	7.2 inches
RF-ON-4H	6 inches
RF-ON-4I	*No Tailings [cover soil to 18 inches]*
RF-ON-5A	*No Tailings*
RF-ON-5B	15 inches
RF-ON-5C	*No Tailings*
RF-ON-5D	12 inches
RF-ON-5E	*No Tailings*
RF-ON-5F	7.2 inches
RF-ON-5G	*No Tailings*
RF-ON-5H	*No Tailings*
RF-ON-6D	*No Tailings*

Soil cover samples collected in May 2001.

Table 4-2
Screening Benchmarks for Aquatic Receptors

Screening Ecological Risk Assessment for the Richardson Flat Tailings

Chemical	$a_{chronic}$	$b_{chronic}$	AWQC Total CCC (ug/L)	$m_{chronic}$	$n_{chronic}$	AWQC Dissolved CCC (ug/L)	AWQC Upper Hardness Limits (mg/L as CaCO3)	Sediment Benchmark (mg/kg)	
			Chronic			Chronic	Chronic		
Aluminum	Not Hardness Dependent		87	1.0	0	87	--	13,500	a
Antimony	Not Hardness Dependent		NA			NA	--	2	c
Arsenic	Not Hardness Dependent		150	1.0	0	150	--	9.79	b
Barium	Not Hardness Dependent		NA			NA	--	NA	
Beryllium	Not Hardness Dependent		NA			NA	--	NA	
Boron	Not Hardness Dependent		NA			NA	--	NA	
Cadmium	0.7409	-4.719	0.5	1.102	0.0418	0.4	209	0.99	b
Calcium	Not Hardness Dependent		NA			NA	--	NA	
Chromium	Not Hardness Dependent		11.0	0.860	0	9	--	43.4	b
Cobalt	Not Hardness Dependent		NA			NA	--	NA	
Copper	0.8545	-1.702	17.7	0.960	0	17	211	31.6	b
Cyanide	Not Hardness Dependant		5.2	1.0	0	5	--	NA	
Iron	Not Hardness Dependant		1,000	1.0	0	1000	--	NA	
Lead	1.273	-4.705	5.4	1.462	0.1457	4	151	38.5	b
Magnesium	Not Hardness Dependent		NA			NA	--	NA	
Manganese	Not Hardness Dependent		NA			NA	--	631	a
Mercury	Not Hardness Dependent		0.77	0.850	0	1	--	0.18	d
Nickel	0.8460	0.0584	97.7	0.997	0	97	210	22.7	b
Potassium	Not Hardness Dependent		NA			NA	--	NA	
Selenium	Not Hardness Dependent		5.0	0.922	0	5	--	NA	
Silver	1.72	-6.52	0.6	0.850	0	0.5	--	0.73	d
Sodium	Not Hardness Dependent		NA			NA	--	NA	
Thallium	Not Hardness Dependent		NA			NA	--	NA	
Vanadium	Not Hardness Dependent		NA			NA	--	NA	
Zinc	0.8473	0.8840	225.6	0.986	0	222	211	121	b

NA = not available

SURFACE WATER AWQC NOTES:

AWQC Source: EPA 822-Z-99-001

Cadmium AWQC Source: EPA-822-R-01-001

Total Selenium CMC Source: EPA-820-B-96-001

For AWQC values that are hardness dependent:

AWQC $Total_{chronic} = exp[a_{chronic}*ln(Hardness)+b_{chronic}]$

AWQC $Dissolved_{chronic}$ = AWQC Total * [m-n*(ln(Hardness)]

Chromium VI AWQC Dissolved used because the screening value is lower than Chromium III.

Selenium AWQC dissolved based on total metals.

Silver AWQC chronic value not available; acute values adjusted by a factor of 100 were used for chronic in the screen.

For table presentation, hardness-dependent values are calculated using an average RFT Site hardness of 466 mg/L.

If measured station hardness is outside of the specified upper hardness limits, the applicable upper hardness limit will be used to calculate the AWQC.

SEDIMENT BENCHMARK SOURCES:

a Ingersoll et al., 1996   c Long & Morgan, 1991

b MacDonald et al., 2000   d MacDonald et al., 1996

Table 4-3
Screening Benchmarks for Terrestrial Receptors

Screening Ecological Risk Assessment for the Richardson Flat Tailings

Chemical	Wildlife Water Ingestion Benchmark (ug/L)[1]	Species	Wildlife Food Ingestion Benchmark (mg/kg dw)[2]	Species	Plant Benchmark (mg/kg dw)[5]	Soil Invertebrate Benchmark (mg/kg dw)[7]	Lowest Soil Screening Benchmark (mg/kg dw)
Aluminum	4,474	Whitetail deer	3.825	Short-tailed shrew	50	600	3.825
Antimony	290	Whitetail deer	0.248	Short-tailed shrew	5	NA	0.248
Arsenic	292	Whitetail deer	0.25	Short-tailed shrew	10	60	0.25
Barium	23,100	Whitetail deer	17.2	American robin	500	3000	17.2
Beryllium	2,830	Whitetail deer	2.42	Short-tailed shrew	10	NA	2.42
Boron	120,000	Whitetail deer	24	American robin	0.5	20	0.5
Cadmium	4,132	Whitetail deer	1.2	American robin	3 [6]	20	1.2
Calcium	NA		NA		NA	NA	NA
Chromium	4,300	Rough-winged swallow	0.83	American robin	1	0.4	0.4
Cobalt	7,670	White-footed mouse[3]	NA		20	1000	20
Copper	65,200	Whitetail deer	38.9	American robin	60 [6]	50	38.9
Cyanide	276,600	Whitetail deer	236	Short-tailed shrew	NA	NA	236
Iron	NA		NA		NA	200	200
Lead	4,860	Rough-winged swallow	0.94	American robin	50	500	0.94
Lithium	40,300	Whitetail deer	35	Cottontail rabbit	2	10	2
Magnesium	NA		NA		NA	NA	NA
Manganese	377,000	Whitetail deer	322	Short-tailed shrew	500	100	100
Mercury	28	Rough-winged swallow	0.005	American robin	0.3	0.1	0.005
Molybdenum	600	Whitetail deer	0.52	Short-tailed shrew	2	200	0.52
Nickel	171,360	Whitetail deer	64.08	American robin	30	90	30
Potassium	NA		NA		NA	NA	NA
Selenium	5	Other Data[4]	0.331	American robin	1	70	0.331
Silver	NA		NA		2	50	2
Sodium	NA		NA		NA	NA	NA
Strontium	1,127,000	Whitetail deer	963	Short-tailed shrew	NA	NA	963
Thallium	32	Whitetail deer	0.027	Short-tailed shrew	1	NA	0.027
Vanadium	835	Whitetail deer	0.714	Short-tailed shrew	2	20	0.714
Zinc	62,300	Rough-winged swallow	12	American robin	50	100	12

NA = not available
dw = dry weight

[1]Lowest reported screening benchmark from Sample et al., 1996. River otter excluded.

[2]Screening benchmark from Sample et al., 1996. Food value used to represent values for ingestion of sediment (see text).

[3]Screening benchmark not reported in Sample et al. (1996). Cobalt value derived using same methodology and a NOAEL of 2.3 mg/kg/day (Pedigo et al., 1988).

[4]Selenium benchmark derived from Skorupa (1998).

[5]Unless noted, screening benchmarks from Efroymson (1997a). Lower of the soil NOEC and LOEC.

[6]Screening values from Kabata-Pendias & Pendias (1992).

[7]Screening benchmarks from Efroymson (1997b). Lower of earthworm and microbial processes benchmarks used.

DRAFT

Table 4-4
Selection of Surface Water COPCs for Aquatic Receptors

Screening Ecological Risk Assessment for the Richardson Flats Tailings Site

	Analyte	Number of Detections	Number of Samples	Detection Frequency (DF)	Mean Non-Detected Conc (ug/L)	Maximum Non-Detected Conc (ug/L)	Mean Detected Conc (ug/L)	Maximum Detected Conc (ug/L)	Aquatic Benchmark (ug/L)	Is Chemical Bio-accumulative? [a]	Is DF > 5%?	Is Max Non-Detect > Benchmark Conc?	Is Chemical an Essential Nutrient?	Is Max Detect > Benchmark Conc?	COPC?	
Dissolved Metals	**Aluminum**	**14**	**106**	**13%**	**24.1**	**50.0**	**95.6**	**190**	**87**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	
	Antimony	**35**	**68**	**51%**	**2.5**	**2.5**	**7.5**	**15**	**NA**	**NO**	**YES**	**DF>5%**	**NO**	**no bnchmark**	**YES**	[4]
	Arsenic	44	160	28%	4.1	10.0	6.7	12	150.0	NO	YES	DF>5%	NO	NO	NO	[4]
	Barium	**83**	**84**	**99%**	**50.0**	**50.0**	**76.6**	**210**	**NA**	**NO**	**YES**	**DF>5%**	**NO**	**no bnchmark**	**YES**	[4]
	Boron	**1**	**1**	**100%**	**NA**	**NA**	**60.0**	**60**	**NA**	**NO**	**YES**	**DF>5%**	**NO**	**no bnchmark**	**YES**	[4]
	Cadmium	**59**	**157**	**38%**	**0.9**	**2.5**	**3.1**	**12**	**0.4**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	
	Calcium	155	155	100%	NA	NA	133650.3	324000	NA	NO	YES	DF>5%	YES	no bnchmark	NO	[3]
	Chromium	**11**	**160**	**7%**	**5.2**	**10.0**	**10.3**	**36**	**9.5**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	
	Copper	**12**	**154**	**8%**	**4.9**	**10.0**	**14.3**	**20**	**17.0**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	
	Iron	49	141	35%	38.6	100.0	111.0	620	1000	NO	YES	DF>5%	YES	NO	NO	[3]
	Lead	**24**	**163**	**15%**	**2.3**	**2.5**	**10.1**	**41**	**3.9**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	
	Magnesium	155	155	100%	NA	NA	32555.1	70000	NA	NO	YES	DF>5%	YES	no bnchmark	NO	[3]
	Manganese	**137**	**138**	**99%**	**2.5**	**2.5**	**776.5**	**9200**	**NA**	**NO**	**YES**	**DF>5%**	**NO**	**no bnchmark**	**YES**	[4]
	Mercury	**41**	**143**	**29%**	**0.1**	**0.3**	**0.0**	**0.22**	**0.7**	**YES**	**YES**	**DF>5%**	**NO**	**NO**	**YES**	[1]
	Potassium	131	133	98%	500.0	500.0	2773.6	6000	NA	NO	YES	DF>5%	YES	no bnchmark	NO	[3]
	Selenium	31	160	19%	2.1	3.5	1.4	3.1	4.6	NO	YES	DF>5%	NO	NO	NO	[4]
	Silver	0	160	0%	2.7	5.0	ND	ND	0.5	NO	NO	YES	NO	YES	NO	[2]
	Sodium	133	133	100%	NA	NA	58267.7	494000	NA	NO	YES	DF>5%	YES	no bnchmark	NO	[3]
	Zinc	**153**	**155**	**99%**	**17.5**	**25.0**	**1140.6**	**83000**	**222**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	
Total Metals	**Aluminum**	**39**	**77**	**51%**	**27.3**	**50.0**	**186**	**1,400**	**87.0**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	
	Antimony	**46**	**74**	**62%**	**2.8**	**12.2**	**11**	**39**	**NA**	**NO**	**YES**	**DF>5%**	**NO**	**no bnchmark**	**YES**	[4]
	Arsenic	**52**	**117**	**44%**	**4.9**	**10.0**	**22**	**750**	**150**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	
	Barium	**43**	**43**	**100%**	**NA**	**NA**	**89**	**220**	**NA**	**NO**	**YES**	**DF>5%**	**NO**	**no bnchmark**	**YES**	[4]
	Beryllium	**6**	**6**	**100%**	**NA**	**NA**	**2**	**3**	**NA**	**NO**	**YES**	**DF>5%**	**NO**	**no bnchmark**	**YES**	[4]
	Cadmium	**55**	**114**	**48%**	**1.1**	**2.5**	**3**	**10**	**0.5**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	
	Calcium	98	98	100%	NA	NA	165,260	404,000	NA	NO	YES	DF>5%	YES	no bnchmark	NO	[3]
	Chromium	11	118	9%	6.6	50.0	2	6	11.0	NO	YES	DF>5%	NO	NO	NO	[4]
	Cobalt	**1**	**6**	**17%**	**3.0**	**3.0**	**10**	**10**	**NA**	**NO**	**YES**	**DF>5%**	**NO**	**no bnchmark**	**YES**	[4]
	Copper	**44**	**130**	**34%**	**4.4**	**10.0**	**27**	**390**	**17.7**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	
	Cyanide	**11**	**85**	**13%**	**2.2**	**5.0**	**11**	**54**	**5.2**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	
	Iron	81	99	82%	47.5	50.0	717	30,000	1,000	NO	YES	DF>5%	YES	YES	NO	[3]
	Lead	**190**	**247**	**77%**	**3.6**	**10.0**	**284**	**26,000**	**5.4**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	
	Magnesium	94	94	100%	NA	NA	39,476	90,000	NA	NO	YES	DF>5%	YES	no bnchmark	NO	[3]
	Manganese	**225**	**225**	**100%**	**NA**	**NA**	**792**	**8,900**	**NA**	**NO**	**YES**	**DF>5%**	**NO**	**no bnchmark**	**YES**	[4]
	Mercury	**49**	**217**	**23%**	**0.6**	**2.5**	**103**	**2,100**	**0.8**	**YES**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	[1]
	Nickel	1	6	17%	5.6	5.6	25	25	98	NO	YES	DF>5%	NO	NO	NO	[4]
	Potassium	52	98	53%	1,527.2	2,500.0	2,925	6,200	NA	NO	YES	DF>5%	YES	no bnchmark	NO	[3]
	Selenium	**6**	**118**	**5%**	**2.6**	**7.5**	**7**	**17**	**5.0**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	
	Silver	**6**	**118**	**5%**	**3.8**	**50.0**	**12**	**25**	**0.6**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	
	Sodium	98	98	100%	NA	NA	53,952	177,000	NA	NO	YES	DF>5%	YES	no bnchmark	NO	[3]
	Thallium	0	6	0%	0.8	0.8	ND	ND	NA	NO	NO	NO	NO	no bnchmark	NO	[2]
	Vanadium	0	6	0%	17.9	17.9	ND	ND	NA	NO	NO	NO	NO	no bnchmark	NO	[2]
	Zinc	**164**	**164**	**100%**	**NA**	**NA**	**1,268**	**96,000**	**225.6**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	

Total COCs 17

Notes

[a] A chemical is identified as bioaccumulative based on the Great Lakes Water Quality Initiative.

[1] Chemical is bioaccumulative.
[2] Detection frequency is less than 5 percent
[3] Analyte is an essential nutrient. Essential nutrients are defined as: calcium, iron, magnesium, potassium and sodium (including dissolved state).
[4] Maximum detected concentration is less than benchmark concentration .
na = not available
no bnchmark = benchmark concentration not available

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Table 4-5
Selection of Surface Water COPCs for Terrestrial Receptors

Screening Ecological Risk Assessment for the Richardson Flats Tailings Site

	Analyte	Number of Detections	Number of Samples	Detection Frequency (DF)	Mean Non-Detected Conc (ug/L)	Maximum Non-Detected Conc (ug/L)	Mean Detected Conc (ug/L)	Maximum Detected Conc (ug/L)	Wildlife Benchmark (ug/L)	Is Chemical Bio-accumulative? [a]	Is DF >5%?	Is Max Non-Detect > Benchmark Conc?	Is Chemical an Essential Nutrient?	Is Max Detect > Benchmark Conc?	COPC?	
Total Metals	Aluminum	39	77	51%	27.3	50.0	186	1,400	4,474	NO	YES	DF>5%	NO	NO	NO	[4]
	Antimony	46	74	62%	2.8	12.2	11	39	290	NO	YES	DF>5%	NO	NO	NO	[4]
	Arsenic	**52**	**117**	**44%**	**4.9**	**10.0**	**22**	**750**	**292**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	
	Barium	43	43	100%	NA	NA	89	220	23,100	NO	YES	DF>5%	NO	NO	NO	[4]
	Beryllium	6	6	100%	NA	NA	2	3	2,830	NO	YES	DF>5%	NO	NO	NO	[4]
	Cadmium	55	114	48%	1.1	2.5	3	10	4,132	NO	YES	DF>5%	NO	NO	NO	[4]
	Calcium	98	98	100%	NA	NA	165,260	404,000	NA	NO	YES	DF>5%	YES	no bnchmark	NO	[3]
	Chromium	11	118	9%	6.6	50.0	2	6	4,300	NO	YES	DF>5%	NO	NO	NO	[4]
	Cobalt	1	6	17%	3.0	3.0	10	10	7,670	NO	YES	DF>5%	NO	NO	NO	[4]
	Copper	44	130	34%	4.4	10.0	27	390	65,200	NO	YES	DF>5%	NO	NO	NO	[4]
	Cyanide	11	85	13%	2.2	5.0	11	54	276,600	NO	YES	DF>5%	NO	NO	NO	[4]
	Iron	81	99	82%	47.5	50.0	717	30,000	NA	NO	YES	DF>5%	YES	no bnchmark	NO	[3]
	Lead	**190**	**247**	**77%**	**3.6**	**10.0**	**284**	**26,000**	**4,860**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	
	Magnesium	94	94	100%	NA	NA	39,476	90,000	NA	NO	YES	DF>5%	YES	no bnchmark	NO	[3]
	Manganese	225	225	100%	NA	NA	792	8,900	377,000	NO	YES	DF>5%	NO	NO	NO	[4]
	Mercury	**49**	**217**	**23%**	**0.6**	**2.5**	**103**	**2,100**	**28**	**YES**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	**[1]**
	Nickel	1	6	17%	5.6	5.6	25	25	171,360	NO	YES	DF>5%	NO	NO	NO	[4]
	Potassium	52	98	53%	1,527.2	2,500.0	2,925	6,200	NA	NO	YES	DF>5%	YES	no bnchmark	NO	[3]
	Selenium	**6**	**118**	**5%**	**2.6**	**7.5**	**7**	**17**	**5**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	
	Silver	**6**	**118**	**5%**	**3.8**	**50.0**	**12**	**25**	**NA**	**NO**	**YES**	**DF>5%**	**NO**	**no bnchmark**	**YES**	**[4]**
	Sodium	98	98	100%	NA	NA	53,952	177,000	NA	NO	YES	DF>5%	YES	no bnchmark	NO	[3]
	Thallium	0	6	0%	0.8	0.8	ND	ND	32	NO	NO	NO	NO	YES	NO	[2]
	Vanadium	0	6	0%	17.9	17.9	ND	ND	835	NO	NO	NO	NO	YES	NO	[2]
	Zinc	**164**	**164**	**100%**	**NA**	**NA**	**1,268**	**96,000**	**62,300**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	

Total COPCs 6

Notes:

[a] A chemical is identified as bioaccumulative based on the Great Lakes Water Quality Initiative.

[1] Chemical is bioaccumulative.
[2] Detection frequency is less than 5 percent.
[3] Analyte is an essential nutrient. Essential nutrients are defined as: calcium, iron, magnesium, potassium and sodium (including dissolved state).
[4] Maximum detected concentration is less than benchmark concentration .
na = not available
no bnchmark = benchmark concentration not available

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Table 4-6
Selection of Sediment COPCs for Aquatic Receptors

Screening Ecological Risk Assessment for the Richardson Flat Tailings Site

Analyte	Number of Detections	Number of Samples	Detection Frequency (DF)	Mean Non-Detected Conc (mg/kg)	Max Non-Detected Conc (mg/kg)	Mean Detected Conc (mg/kg)	Max Detected Conc (mg/kg)	Sediment Benchmark (mg/kg)	Is Chemical Bio-accumulative?	Is DF > 5%?	Is Max Non-Detect > Benchmark Conc?	Is Chemical an Essential Nutrient?	Is Max Detect Conc > Sediment Benchmark?	COPC?	
Aluminum	**22**	**22**	**100%**	**NA**	**NA**	**11,085**	**28,800**	**13,500**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	**[4]**
Antimony	**22**	**22**	**100%**	**NA**	**NA**	**130**	**889**	**2.0**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	**[4]**
Arsenic	**22**	**23**	**96%**	**33**	**33**	**284**	**1,735**	**9.8**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	**[4]**
Barium	**5**	**5**	**100%**	**NA**	**NA**	**276**	**562**	**NA**	**NO**	**YES**	**DF>5%**	**NO**	**no bnchmrk**	**YES**	**[5]**
Beryllium	**5**	**5**	**100%**	**NA**	**NA**	**1.8**	**2.3**	**NA**	**NO**	**YES**	**DF>5%**	**NO**	**no bnchmrk**	**YES**	**[5]**
Cadmium	**23**	**23**	**100%**	**NA**	**NA**	**54**	**179**	**1.0**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	**[4]**
Calcium	5	5	100%	NA	NA	58,780	96,000	NA	NO	YES	DF>5%	YES	no bnchmrk	NO	[2]
Chromium	**23**	**23**	**100%**	**NA**	**NA**	**27**	**62**	**43**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	**[4]**
Cobalt	**5**	**5**	**100%**	**NA**	**NA**	**14**	**20**	**NA**	**NO**	**YES**	**DF>5%**	**NO**	**no bnchmrk**	**YES**	**[5]**
Copper	**23**	**23**	**100%**	**NA**	**NA**	**555**	**2,559**	**32**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	**[4]**
Iron	23	23	100%	NA	NA	49,573	156,800	NA	NO	YES	DF>5%	YES	no bnchmrk	NO	[2]
Lead	**23**	**23**	**100%**	**NA**	**NA**	**6,407**	**42,990**	**39**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	**[4]**
Magnesium	5	5	100%	NA	NA	12,960	14,100	NA	NO	YES	DF>5%	YES	no bnchmrk	NO	[2]
Manganese	**5**	**5**	**100%**	**NA**	**NA**	**10,938**	**42,000**	**631**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	**[4]**
Mercury	**22**	**23**	**96%**	**0.1**	**0.1**	**1.5**	**8.2**	**0.18**	**YES**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	**[3]**
Nickel	**5**	**5**	**100%**	**NA**	**NA**	**45**	**97**	**23**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	**[4]**
Potassium	5	5	100%	NA	NA	2,847	4,760	NA	NO	YES	DF>5%	YES	no bnchmrk	NO	[2]
Selenium	**16**	**23**	**70%**	**7.6**	**34**	**15**	**43**	**NA**	**NO**	**YES**	**DF>5%**	**NO**	**no bnchmrk**	**YES**	**[5]**
Silver	**23**	**23**	**100%**	**NA**	**NA**	**32**	**136**	**0.7**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	**[4]**
Sodium	5	5	100%	NA	NA	603	1,150	NA	NO	YES	DF>5%	YES	no bnchmrk	NO	[2]
Thallium	**5**	**5**	**100%**	**NA**	**NA**	**8.6**	**14**	**NA**	**NO**	**YES**	**DF>5%**	**NO**	**no bnchmrk**	**YES**	**[5]**
Vanadium	**5**	**5**	**100%**	**NA**	**NA**	**38**	**71**	**NA**	**NO**	**YES**	**DF>5%**	**NO**	**no bnchmrk**	**YES**	**[5]**
Zinc	**23**	**23**	**100%**	**NA**	**NA**	**10,222**	**44,560**	**121**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES**	**[4]**

TOTAL COPCs: 18

Notes:

[1] Detection frequency is less than 5 percent.
[2] Analyte is an essential nutrient. Essential nutrients are defined as: calcium, iron, magnesium, potassium and sodium.
[3] Identified as bioaccumulative based on the Great Lakes Water Quality Guidance (GLWQG) wildlife Tier I criteria.
[4] Analyte concentrations are greater than the benchmark value.
[5] No benchmark value available.

NA = not available
ND = not detected
no bnchmrk = no benchmark

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Table 4-7
Selection of Sediment COPCs for Terrestrial Receptors

Screening Ecological Risk Assessment for the Richardson Flat Tailings Site

Analyte	Number of Detections	Number of Samples	Detection Frequency (DF)	Mean Non-Detected Conc (mg/kg)	Max Non-Detected Conc (mg/kg)	Mean Detected Conc (mg/kg)	Max Detected Conc (mg/kg)	Sediment Benchmark (mg/kg)	Is Chemical Bio-accumulative?	Is DF > 5%?	Is Max Non-Detect > Benchmark Conc?	Is Chemical an Essential Nutrient?	Is Max Detect Conc > Sediment Benchmark?	COPC?
Aluminum	**22**	**22**	**100%**	**NA**	**NA**	**11,085**	**28,800**	**3.8**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES [4]**
Antimony	**22**	**22**	**100%**	**NA**	**NA**	**130**	**889**	**0.2**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES [4]**
Arsenic	**22**	**23**	**96%**	**33**	**33**	**284**	**1,735**	**0.3**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES [4]**
Barium	**5**	**5**	**100%**	**NA**	**NA**	**276**	**562**	**17**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES [4]**
Beryllium	5	5	100%	NA	NA	1.8	2.3	2	NO	YES	DF>5%	NO	NO	NO
Cadmium	**23**	**23**	**100%**	**NA**	**NA**	**54**	**179**	**1.2**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES [4]**
Calcium	*5*	*5*	*100%*	*NA*	*NA*	*58,780*	*96,000*	*NA*	*NO*	*YES*	*DF>5%*	*YES*	*no bnchmrk*	*NO [2]*
Chromium	**23**	**23**	**100%**	**NA**	**NA**	**27**	**62**	**0.83**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES [4]**
Cobalt	**5**	**5**	**100%**	**NA**	**NA**	**14**	**20**	**NA**	**NO**	**YES**	**DF>5%**	**NO**	**no bnchmrk**	**YES [5]**
Copper	**23**	**23**	**100%**	**NA**	**NA**	**555**	**2,559**	**39**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES [4]**
Iron	23	23	100%	NA	NA	49,573	156,800	NA	NO	YES	DF>5%	YES	no bnchmrk	NO [2]
Lead	**23**	**23**	**100%**	**NA**	**NA**	**6,407**	**42,990**	**0.94**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES [4]**
Magnesium	5	5	100%	NA	NA	12,960	14,100	NA	NO	YES	DF>5%	YES	no bnchmrk	NO [2]
Manganese	***5***	***5***	***100%***	***NA***	***NA***	***10,938***	***42,000***	***322***	***NO***	***YES***	***DF>5%***	***NO***	***YES***	***YES [4]***
Mercury	**22**	**23**	**96%**	**0.1**	**0.1**	**1.5**	**8.2**	**0.01**	**YES**	**YES**	**DF>5%**	**NO**	**YES**	**YES [3]**
Nickel	**5**	**5**	**100%**	**NA**	**NA**	**45**	**97**	**64**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES [4]**
Potassium	5	5	100%	NA	NA	2,847	4,760	NA	NO	YES	DF>5%	YES	no bnchmrk	NO [2]
Selenium	**16**	**23**	**70%**	**7.6**	**34**	**15**	**43**	**0.33**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES [4]**
Silver	**23**	**23**	**100%**	**NA**	**NA**	**32**	**136**	**NA**	**NO**	**YES**	**DF>5%**	**NO**	**no bnchmrk**	**YES [5]**
Sodium	5	5	100%	NA	NA	603	1,150	NA	NO	YES	DF>5%	YES	no bnchmrk	NO [2]
Thallium	***5***	***5***	***100%***	***NA***	***NA***	***8.6***	***14***	***0.03***	***NO***	***YES***	***DF>5%***	***NO***	***YES***	***YES [4]***
Vanadium	**5**	**5**	**100%**	**NA**	**NA**	**38**	**71**	**0.71**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES [4]**
Zinc	**23**	**23**	**100%**	**NA**	**NA**	**10,222**	**44,560**	**12**	**NO**	**YES**	**DF>5%**	**NO**	**YES**	**YES [4]**

TOTAL COPCs: 17

Notes:

[1] Detection frequency is less than 5 percent.
[2] Analyte is an essential nutrient. Essential nutrients are defined as: calcium, iron, magnesium, potassium and sodium.
[3] Identified as bioaccumulative based on the Great Lakes Water Quality Guidance (GLWQG) wildlife Tier I criteria
[4] Analyte concentrations are greater than the benchmark value.
[5] No benchmark value available.

NA = not available
ND = not detected
no bnchmrk = no benchmark

Table 4-8
Selection of Soil and Tailings COPCs for Terrestrial Receptors

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Screening Ecological Risk Assessment for the Richardson Flat Tailings Site

Analyte	Number of Detections	Number of Samples	Detection Frequency (DF)	Mean Non-Detected Conc (mg/kg)	Max Non-Detected Conc (mg/kg)	Mean Detected Conc (mg/kg)	Max Detected Conc (mg/kg)	Sediment Benchmark (mg/kg)	Is Chemical Bio-accumulative?	Is DF > 5%?	Is Max Non-Detect > Benchmark Conc?	Is Chemical an Essential Nutrient?	Is Max Detect Conc > Soil Benchmark?	COPC?
Aluminum	51	51	100%	NA	NA	10,662	32,700	3.8	NO	YES	DF>5%	NO	YES	YES [4]
Antimony	34	51	67%	3	3	153	505	0.2	NO	YES	DF>5%	NO	YES	YES [4]
Arsenic	182	188	97%	3	3	83	637	0.3	NO	YES	DF>5%	NO	YES	YES [4]
Barium	30	30	100%	NA	NA	262	413	17	NO	YES	DF>5%	NO	YES	YES [4]
Cadmium	64	87	74%	0	0	34.8	250.0	1	NO	YES	DF>5%	NO	YES	YES [4]
Chromium	80	81	99%	3	3	23	111	0.8	NO	YES	DF>5%	NO	YES	YES [4]
Copper	89	89	100%	NA	NA	219	1,323	39	NO	YES	DF>5%	NO	YES	YES [4]
Iron	51	51	100%	NA	NA	33,368	77,500	NA	NO	YES	DF>5%	YES	no bnchmrk	NO [2]
Lead	185	185	100%	NA	NA	1,666	31,600	1	NO	YES	DF>5%	NO	YES	YES [4]
Mercury	52	86	60%	0	0	5	85	0	YES	YES	DF>5%	NO	YES	YES [3]
Selenium	26	81	32%	3	3	12	24	0	NO	YES	DF>5%	NO	YES	YES [4]
Silver	38	87	44%	3	3	37	120	NA	NO	YES	DF>5%	NO	no bnchmrk	YES [5]
Zinc	88	88	100%	NA	NA	4,085	33,800	12	NO	YES	DF>5%	NO	YES	YES [4]

TOTAL COPCs 12

Notes:

[1] Detection frequency is less than 5 percent.
[2] Analyte is an essential nutrient. Essential nutrients are defined as: calcium, iron, magnesium, potassium and sodium.
[3] Identified as bioaccumulative based on the Great Lakes Water Quality Guidance (GLWQG) wildlife Tier I criteria.
[4] Analyte concentrations are greater than the benchmark value.
[5] No benchmark value available.

NA = not available
ND = not detected
no bnchmrk = no benchmark

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Table 5-1
Surface Water Exposure Point Concentrations for Aquatic Receptors and Amphibians

Screening Ecological Risk Assessment for Richardson Flat Tailings

Location	Station	TOTAL (ug/L)											DISSOLVED (ug/L)										
		Aluminum	Arsenic	Cadmium	Chromium	Copper	Cyanide	Lead	Mercury	Selenium	Silver	Zinc	Aluminum	Arsenic	Cadmium	Chromium	Copper	Cyanide	Lead	Mercury	Selenium	Silver	Zinc
Silver Creek - upstream	USC-7	710	2.5	10.0	4.4	18	na	27	0.052	2.5	2.1	2,500	25	5.0	7.0	4.4	12.0	na	2.3	0.004	2.5	2.1	2,100
	USC-6	25	19.0	2.0	5.0	6	na	31	0.042	2.5	2.5	1,400	25	8.0	2.0	5.0	2.5	na	2.5	0.004	2.5	2.5	1,400
	492685	na	na	na	na	na	na	na	na	na	na	na	29	3.3	3.3	3.3	7.8	na	6.3	0.100	1.8	1.0	1,170
	USC-5	25	2.5	6.0	5.0	9	na	26	na	2.5	2.5	1,900	25	5.0	1.0	5.0	7.0	na	2.5	na	2.5	2.5	2,000
	USC-3	69	7.0	3.0	5.0	7	na	41	na	2.5	2.5	1,200	170	7.0	1.0	5.0	2.5	na	2.5	na	2.5	2.5	1,100
	RF-SW-01	20	4.2	3.9	3.9	10	na	35	0.100	7.5	1.2	1,110	na	na	na	na	na	na	na	na	na	na	na
	RF-SW-02	70	5.2	1.7	3.9	10	na	19	0.100	7.5	1.2	2,080	na	na	na	na	na	na	na	na	na	na	na
	RF-SW-03	19	7.3	1.7	3.9	10	na	15	0.100	7.5	1.2	769	na	na	na	na	na	na	na	na	na	na	na
	N4	na	na	na	na	390	6.4	1480	143	na	na	1,350	na	na	na	na	na	na	20.0	na	na	na	560
	RF-SW-04	66	7.6	3.5	3.9	10	na	36	0.100	7.5	1.2	776	na	na	na	na	na	na	na	na	na	na	na
	RF-7	25	10.0	4.0	7.5	13	na	74	0.250	2.5	4.4	96,000	25	7.0	2.0	7.5	4.2	na	2.5	0.250	2.5	4.4	83,000
	RF-7-2	100	13.0	8.0	3.0	8	2.0	78	0.243	4.7	12.6	2,100	88	8.2	6.0	6.0	6.5	na	4.9	0.220	2.3	3.8	2,000
	492695	na	na	na	na	na	na	na	na	na	na	na	65	2.5	12.0	3.6	8.6	na	5.0	0.100	2.0	1.0	1,011
Silver Creek - downstream	RF-SW-05	9	7.2	1.7	3.9	10	na	151	0.100	7.5	1.2	466	na	na	na	na	na	na	na	na	na	na	na
	RF-SW-06	185	12.5	1.7	3.9	10	na	33	0.100	7.5	10.0	321	na	na	na	na	na	na	na	na	na	na	na
	N6	na	na	na	na	10	2.7	145	133	na	na	902	na	na	na	na	na	na	25.0	na	na	na	370
	USC-2	25	2.5	2.0	5.0	3	na	16	na	2.5	7.0	630	25	7.0	1.5	5.0	2.5	na	12.0	na	2.5	2.5	710
	USC-1	350	6.0	2.0	5.0	12	na	51	0.113	2.5	2.5	1,100	25	6.0	1.8	5.0	2.5	na	2.5	0.002	2.5	2.5	1,000
	RF-8	330	31.0	9.0	4.0	10	2.0	340	0.350	5.0	4.9	1,700	33	8.2	2.1	8.7	4.1	na	5.6	0.220	2.4	3.9	1,100
	RF-8-2	na	10.0	3.0	10.0	5	na	28	0.250	2.5	5.0	850	na	10.0	2.0	10.0	5.0	na	2.5	0.250	2.5	5.0	850
	492679	50	8.7	0.5	5.8	6	5.0	2	0.100	0.5	1.0	170	15	12.0	0.5	2.5	6.0	na	1.5	0.100	1.2	1.0	330
	492680	na	na	na	na	na	na	na	na	na	na	na	15	7.6	1.1	2.5	6.0	na	9.8	0.100	1.2	1.0	765
South Diversion Ditch	RF-2	580	5.0	0.5	7.5	18	na	5	0.280	2.3	3.8	94	190	6.0	0.5	7.5	16.0	na	5.0	0.200	2.3	3.8	79
	RF-4	480	8.0	2.0	0.0	17	na	3	0.345	2.2	3.3	2,700	61	8.0	0.5	6.1	11.2	na	3.6	0.200	2.2	3.3	2,600
	RF-5	340	6.0	1.0	0.0	12	na	9	0.256	0.0	9.9	900	45	5.0	0.5	6.0	9.1	na	2.5	0.220	2.2	3.6	860
	RF-5-4	470	8.0	2.0	5.0	18	na	3	0.240	2.0	2.5	2,600	69	7.0	0.5	5.0	17.0	na	2.5	0.220	2.0	2.5	2,500
	N5	na	na	na	na	11	na	45	0.200	na	na	918	na	na	na	na	na	na	na	na	na	na	na
	USC-4	25	6.0	1.8	5.0	6	na	11	0.002	2.5	2.5	110	25	2.5	1.8	36.0	2.5	na	2.5	0.001	2.5	2.5	100
	RF-6	na	6.0	2.0	4.0	5	2.0	48	0.233	3.7	4.5	850	na	6.0	1.7	10.0	5.0	na	2.5	0.250	2.6	4.4	850
	RF-6-2	165	750	0.0	0.0	10	na	16	0.320	5.9	4.8	310	33	3.9	0.6	6.8	6.9	na	3.6	0.002	2.1	3.4	150
Site Ponded Water	RF-9	na	10.0	0.5	10.0	5	na	3	0.250	2.5	5.0	11	na	10.0	0.5	10.0	5.0	na	2.5	0.250	2.5	5.0	29
Unnamed Drainage	RF-3-2	1400	17.0	0.0	0.0	22	na	7	0.240	2.0	2.5	98	89	10.0	0.0	5.0	20.0	na	5.0	0.220	2.0	2.5	77

Table 5-2
Sediment Exposure Point Concentrations for Aquatic Receptors

Screening Ecological Risk Assessment for Richardson Flat Tailings

Location	Station	Aluminum	Antimony	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Mercury	Nickel	Silver	Zinc
Silver Creek - upstream	USC-5	15,220	175	393	65	31	1,380	11,190	na	0	na	48	12,270
	USC-6	4,930	889	1,735	179	15	2,559	42,990	na	2	na	136	44,560
	USC-7	14,720	64	105	28	42	652	2,656	na	1	na	51	4,619
Silver Creek - downstream	USC-1	11,250	140	341	50	30	766	11,130	na	0	na	49	11,730
	USC-2	11,590	137	271	58	32	588	6,942	na	0	na	40	11,950
South Diversion Ditch	RF-SD-SD1	4,850	72	156	73	18	280	3,490	na	2	na	25	12,000
	RF-SD-SD2	6,450	53	119	50	16	200	2,330	na	1	na	16	8,780
	RF-SD-SD3	10,500	36	125	35	21	173	1,880	na	0	na	13	6,800
	RF-SD-SD4	7,480	65	205	51	18	260	2,840	na	1	na	19	9,140
	RF-SD-SD5	8,650	97	119	38	18	261	2,660	na	1	na	20	7,610
	RF-SD-SD6	20,600	63	101	18	30	211	2,280	na	2	na	14	2,940
South Diversion Ditch - Wetland Area	RF-SE-01	28,800	99	202	93	62	725	6,520	5,060	8	51	41	15,200
	RF-SE-02	1,930	85	189	53	16	183	3,010	2,200	3	13	11	8,160
	RF-SE-03	4,530	99	310	65	15	313	5,220	2,330	2	21	16	11,200
	RF-SE-04	11,800	40	189	40	25	190	2,350	42,000	1	97	8	5,400

All units are in mg/kg.

Table 5-3
Seep* Water Exposure Point Concentrations for Aquatic Receptors and Amphibians

Screening Ecological Risk Assessment for Richardson Flat Tailings

COPC	Monitoring wells below main embankment					Upgradient monitoring well
	MW-01	MW-03	MW-04	MW-05	MW-06	RT-1
			TOTAL			
Aluminum	80,700	na	na	na	4,920	15,700
Arsenic	76	na	na	na	349	4
Cadmium	42	na	na	na	16	3
Chromium	95	na	na	na	42	11
Copper	1583	10	15	15	190	30
Cyanide	32	8	11,816	37	1,552	5
Lead	88	69	120	131	142	627
Mercury	0.3	2.1	0.7	2.2	0.5	0.2
Selenium	15	na	na	na	15	3
Silver	2	na	na	na	17	2
Zinc	650	na	na	na	2,790	136
			DISSOLVED			
Aluminum	50	na	na	na	69	191
Arsenic	4	na	na	na	9	4
Cadmium	3	na	na	na	3	3
Chromium	8	na	na	na	8	8
Copper	20	na	na	na	20	171
Cyanide	na	na	na	na	na	na
Lead	92	49	58	61	37	41
Mercury	0.2	na	na	na	0.2	0.2
Selenium	15	na	na	na	15	3
Silver	10	na	na	na	10	10
Zinc	108	70	200	1,900	73	20

*Seep water concentrations estimated from available groundwater.
All units in ug/L.

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Table 5-4
Exposure Factors for Representative Wildlife Species

Screening Level Ecological Risk Assessment for the Richardson Flat Tailings Site

Class	Type		Receptor	*Genus species*	Body Weight (kg wet weight)	Food Ingestion Rate (kg wet weight/day)	Water Ingestion Rate (L/day)	Sediment Ingestion Rate [a] (kg dry weight/day)	Soil Ingestion Rate [b] (kg dry weight/day)	Dietary Fraction (df)
Avian	Terrestrial	Herbivore	Greater-Sage Grouse	*Centrocercus urophasianus*	2.3	0.100	1.031	NA	0.0007	100% terrestrial plants
		Insectivore	American Robin	*Turdus migratorius*	0.081	0.078	0.011	NA	0.0012	100% soil invertebrates
		Carnivore	American Kestrel	*Falco sparverius*	0.115	0.033	0.014	NA	0.0001	100% small mammals
	Aquatic	Insectivore	Mallard Duck	*Anas platyrhynchos*	1.13	0.316	0.064	0.002	NA	100% aquatic invertebrates
		Piscivore	Belted Kingfisher	*Ceryle alcyon*	0.147	0.073	0.016	0.0002	NA	100% fish
Mammalian	Terrestrial	Carnivore	Red Fox	*Vulpes vulpes*	4.54	0.310	0.386	NA	0.0023	100% small mammals
		Insectivore	Masked Shrew	*Sorex cinereus*	0.0053	0.009	0.001	NA	0.0004	100% soil invertebrates
		Herbivore	Deer Mice	*Peromyscus maniculatus*	0.02	0.005	0.00	NA	0.00006	100% vegetation
	Semi-Aquatic	Piscivore	Mink	*Mustela vison*	0.556	0.089	0.058	0.0002	NA	100% fish

NA = Not applicable
a Assumed to be equal to soil if not applicable (NA)
b Assumed to be equal to sediment if not applicable (NA)

Table 5-5
Surface Water Exposure Point Concentrations for Wildlife

Screening Ecological Risk Assessment for Richardson Flat Tailings

COPC	Silver Creek - upstream	Silver Creek - downstream	Unnamed Drainages	Ponded Water	South Diversion Ditch
Arsenic	18	23	17	10	68
Lead	953	165	7.0	2.5	17
Mercury	90	75	0.24	0.25	0.48
Selenium	4.1	5.0	2.0	2.5	4.7
Silver	6.9	4.9	2.5	5.0	4.9
Zinc	5,666	1,426	98	11	2,380

All units are in ug/L.

Table 5-6
Sediment Exposure Point Concentrations for Wildlife

Screening Ecological Risk Assessment for Richardson Flat Tailings

COPC	Silver Creek - upstream	Silver Creek - downstream	South Diversion Ditch	Wetlands Area
Aluminum	15,220	11,590	15,125	28,800
Antimony	889	140	93	99
Arsenic	1,735	341	163	300
Barium	na	na	na	562
Cadmium	179	58	66	93
Chromium	42	32	24	62
Cobalt	na	na	na	20
Copper	2,559	766	270	725
Lead	42,990	11,130	3,042	6,520
Manganese	na	na	na	42,000
Mercury	1.60	0.44	1.60	8.2
Nickel	na	na	na	97
Selenium	32	11	7.0	43
Thallium	na	na	na	12
Vanadium	na	na	na	71
Zinc	44,560	11,950	12,000	15,200

All units are in mg/kg.

Table 5-7
Soil and Tailings Exposure Point Concentrations for Wildlife

Screening Ecological Risk Assessment for Richardson Flat Tailings

COPC	Background Soils	Off-Impoundment Soils	On-Impoundment Soils	Tailings
Aluminum	na	na	23,739	na
Antimony	na	na	4.4	na
Arsenic	10	43	24	na
Barium	265	331	277	na
Cadmium	1.0	15	2.0	na
Chromium	23	24	24	na
Copper	29	49	42	na
Lead	59	806	429	na
Mercury	0.15	1.3	0.32	na
Selenium	2.5	2.5	2.5	na
Zinc	127	551	314	na

All units in mg/kg.

Table 5-8
Estimated Concentrations of COPCs in Food Items for Wildlife
Screening Ecological Risk Assessment for Richardson Flat Tailings

Designated Reach	Parameter	Estimated Concentration (mg/kg ww)					
		Benthic Invertebrates	Fish	Exposure Area	Plants	Soil Invertebrates	Small Mammal*
Upstream Silver Creek	Aluminum	2283	15220	Background Soils	na	na	na
	Antimony	133	889		na	na	na
	Arsenic	180	1735		0.27	1.04	0.038
	Barium	na	na		na	na	1.6
	Cadmium	1116	179		0.33	7.0	1.5
	Chromium	2.9	42		na	0.84	1.6
	Copper	9162	2559		3.9	10.9	10.2
	Lead	3914	42990		1.8	18.1	8.0
	Mercury	0.69	1.6		0.07	0.48	0.0056
	Selenium	4.8	32		0.74	1.53	0.63
	Silver	na	136		na	na	na
	Zinc	50310	44560		38	352	85
Downstream Silver Creek	Aluminum	1739	11590	Off-Impoundment Soils	na	na	na
	Antimony	21	140		na	na	na
	Arsenic	35	341		0.17	2.9	0.17
	Barium	na	na		na	na	3.8
	Cadmium	361	58		1.5	61	21
	Chromium	2.2	32		na	0.84	1.6
	Copper	2743	766		4.8	12.6	11
	Lead	1013	11130		6	150	29
	Mercury	0.19	0.44		0.23	1.00	0.048
	Selenium	1.7	11		0.74	1.53	0.66
	Silver	na	49		na	na	na
	Zinc	13492	11950		164	103	840
South Diversion Ditch	Aluminum	2269	15125	On-Impoundment Soils	na	na	na
	Antimony	14	93		na	na	na
	Arsenic	16.9	163		0.43	1.92	0.089
	Barium	na	na		na	na	3.2
	Cadmium	412	66		0.48	12.2	3.0
	Chromium	1.7	24		na	0.84	1.64
	Copper	965	270		4.5	12.0	10.9
	Lead	277	3042		4.2	90	21
	Mercury	0.69	1.6		0.11	0.62	0.012
	Selenium	1.0	7.0		0.74	1.53	0.63
	Silver	na	21.9		na	na	na
	Zinc	13549	12000		62	474	91
Wetlands Area	Aluminum	4320	28800	Tailings	na	na	na
	Antimony	15	99		na	na	na
	Arsenic	31	300		2.66	18.5	3.4
	Barium	84.3	562		na	na	na
	Cadmium	580	93		6.1	493	269
	Chromium	4.4	62		na	0.8	1.8
	Cobalt	16	20		na	na	na
	Copper	2596	725		13.2	24.7	23.0
	Lead	594	6520		47	2890	171
	Manganese	6300	42000		na	na	na
	Mercury	3.5	8		0.92	2.4	0.63
	Nickel	33.8	97		na	na	na
	Selenium	6.5	43		4.2	4.8	1.1
	Silver	na	41		na	na	na
	Thallium	1.8	12		na	na	na
	Vanadium	11	71		na	na	na
	Zinc	17162	15200		659	1910	124

* Tissue concentrations predicted for herbivores, omnivores and carnivores in Appendix E. The highest concentration is used in the estimation of dietary doses for wildlife species consuming small mammals.

Table 6-1
Ambient Water Quality Criteria for Aquatic Receptors

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Screening Ecological Risk Assessment for the Richardson Flat Tailings

Chemical	a_{acute}	b_{acute}	$a_{chronic}$	$b_{chronic}$	AWQC Total CMC (ug/L)	AWQC Total CCC (ug/L)	m_{acute}	n_{acute}	$m_{chronic}$	$n_{chronic}$	AWQC Dissolved CMC (ug/L)	AWQC Dissolved CCC (ug/L)	AWQC Upper Hardness Limits (mg/L as CaCO3)	
					Acute	Chronic					Acute	Chronic	Acute	Chronic
Aluminum	Not Hardness Dependant				750	87	1.0	0	1.0	0	750	87	--	--
Antimony					NA	NA					NA	NA	--	--
Arsenic	Not Hardness Dependant				340	150	1.0	0	1.0	0	340	150	--	--
Barium					NA	NA					NA	NA	--	--
Beryllium					NA	NA					NA	NA	--	--
Boron					NA	NA					NA	NA	--	--
Cadmium	1.0166	-3.924	0.7409	-4.719	2.1	0.3	1.137	0.0418	1.102	0.0418	2.0	0.2	360	209
Calcium					NA	NA					NA	NA	--	--
Chromium	Not Hardness Dependant				16.0	11.0	0.316	0	0.860	0	5.1	9.5	--	--
Cobalt					NA	NA					NA	NA	--	--
Copper	0.9422	-1.700	0.8545	-1.702	14.0	9.3	0.960	0	0.960	0	13.4	9.0	400	211
Cyanide	Not Hardness Dependant				22	5.2	1.0	0	1.0	0	22.0	5.2	--	--
Iron	Not Hardness Dependant				NA	1,000	1.0	0	1.0	0	NA	1000	--	--
Lead	1.273	-1.460	1.273	-4.705	81.6	3.2	1.462	0.1457	1.462	0.1457	64.6	2.5	360	151
Lithium					NA	NA					NA	NA	--	--
Magnesium					NA	NA					NA	NA	--	--
Manganese					NA	NA					NA	NA	--	--
Mercury	Not Hardness Dependant				1.4	0.77	0.850	0	0.850	0	1.2	0.7	--	--
Molybdenum					NA	NA					NA	NA	--	--
Nickel	0.8460	2.255	0.8460	0.0584	469.2	52.2	0.998	0	0.997	0	468.2	52.0	360	210
Potassium					NA	NA					NA	NA	--	--
Selenium	Not Hardness Dependant				19.3	5.0	0.922	0	0.922	0	17.8	4.6	--	--
Silver	1.72	-6.52			4.1	NA	0.850	0			3	NA	350	--
Sodium					NA	NA					NA	NA	--	--
Strontium					NA	NA					NA	NA	--	--
Thallium					NA	NA					NA	NA	--	--
Vanadium					NA	NA					NA	NA	--	--
Zinc	0.8473	0.8840	0.8473	0.8840	119.8	119.8	0.978	0	0.986	0	117	118	500	211

NA = not available

SURFACE WATER AWQC NOTES:
AWQC Source: EPA 822-Z-99-001
Cadmium SWQC Source: EPA-822-R-01-001
Total Selenium CMC Source: EPA-820-B-96-001

For AWQC values that are hardness dependant:
AWQC $Total_x = \exp[a_x*\ln(Hardness)+b_x]$
AWQC $Dissolved_x$ = AWQC Total * [m-n*(ln(Hardness))]
where: x is either acute or chronic

Chromium VI AWQC Dissolved used because the screening value is lower than Chromium III.
Selenium AWQC dissolved based on total metals.

For table presentation, hardness-dependent values are calculated using a hardness of 100 mg/L.
If measured station hardness is outside of the specified upper hardness limits, the applicable upper hardness limit will be used to calculate the AWQC.

Table 6-2
Sediment Toxicity Benchmarks

Screening Ecological Risk Assessment for the Richardson Flat Tailings

Analyte	Sediment Effect Concentrations (SEC)					Selected Toxicity Benchmark (mg/kg)			Benchmark Source
	Effects Range Low (ERL)	Effects Range Median (ERM)	Threshold Effects Level (TEL)	Probable Effects Level (PEL)	No Effect Conc (NEC)	Low Benchmark (TEC)	High Benchmark (PEC)		
Aluminum	13,500	58,030	25,519	59,572	73,160	13,500	73,160	a	Ingersoll et al., 1996
Antimony	2	25	NA	NA	NA	2	25	b	Long & Morgan, 1991
Arsenic						9.79	33	c	MacDonald et al., 2000
Barium	NA	NA	NA	NA	NA	NA	NA		--
Beryllium	NA	NA	NA	NA	NA	NA	NA		--
Cadmium						0.99	4.98	c	MacDonald et al., 2000
Chromium						43.4	111	c	MacDonald et al., 2000
Cobalt	NA	NA	NA	NA	NA	NA	NA		--
Copper						31.6	149	c	MacDonald et al., 2000
Cyanide	NA	NA	NA	NA	NA	NA	NA		--
Lead						35.8	128	c	MacDonald et al., 2000
Manganese	726	1,673	631	1,185	4,460	631	4,460	a	Ingersoll et al., 1996
Mercury						0.18	1.06	c	MacDonald et al., 2000
Nickel						22.7	48.6	c	MacDonald et al., 2000
Selenium	NA	NA	NA	NA	NA	NA	NA		--
Silver	1	3.7	0.73	1.77	NA	0.73	3.7	d	MacDonald et al., 1996
Thallium	NA	NA	NA	NA	NA	NA	NA		--
Vanadium	NA	NA	NA	NA	NA	NA	NA		--
Zinc						121	459	c	MacDonald et al., 2000

All units are in mg/kg.

NA = Not Available

a Consensus-based values from MacDonald et al. (2000) not available -- selected toxicity values are based on the minimum and maximum reported benchmarks from Ingersoll et al. (1996). Toxicity values from Ingersoll et al. (1996) are based on 28 day Hyalella azteca (HA28) toxicity studies and total extraction of sediment (BT).

Table 6-3
Screening Benchmarks for Amphibian Receptors from Aqueous Exposures

Screening Ecological Risk Assessment for Richardson Flat Tailings

Analyte	Number of Endpoint Values	Species	Endpoint	Exposure Duration	Source	Conc (ug/L)	Aqueous Screening Benchmark (ug/L)*
Antimony	2	Eastern Narrow-Mouthed Toad (*Gastrophryne carolinensis*)	LC_{50}	7 days	Birge (1978) & Birge et al. (1979)	300	30
Arsenic	2	Eastern Narrow-Mouthed Toad (*Gastrophryne carolinensis*)	LC_{50}	7 days	Birge (1978) & Birge et al. (1979)	40	4.0
Cadmium	205	Eastern Narrow-Mouthed Toad (*Gastrophryne carolinensis*)	LC_{50}	7 days	Birge et al. (1979)	40	4.0
Copper	63	Eastern Narrow-Mouthed Toad (*Gastrophryne carolinensis*)	LC_{50}	7 days	Birge et al. (1979)	40	4.0
Cyanide	9	Frog (*Rana temporaria*)	Avoidance	Not Reported	Costa (1965)	260	0.26
Lead	32	Eastern Narrow-Mouthed Toad (*Gastrophryne carolinensis*)	LC_{50}	Not Reported	Birge et al. (1979)	40	4.0
Mercury	38	Eastern Narrow-Mouthed Toad (*Gastrophryne carolinensis*)	LC_{50}	7 days	Birge et al. (1979)	1	0.1
Nickel	10	Eastern Narrow-Mouthed Toad (*Gastrophryne carolinensis*)	LC_{50}	7 days	Birge (1978) & Birge et al. (1979)	50	5.0
Selenium	13	Eastern Narrow-Mouthed Toad (*Gastrophryne carolinensis*)	LC_{50}	7 days	Birge (1978) & Birge et al. (1979)	90	9.0
Silver	11	Eastern Narrow-Mouthed Toad (*Gastrophryne carolinensis*)	LC_{50}	7 days	Birge (1978)	10	1.0
Zinc	66	Eastern Narrow-Mouthed Toad (*Gastrophryne carolinensis*)	LC_{50}	7 days	Birge et al. (1979)	10	1.0

Lowest exposure concentration selected for screening benchmark.
Mercury benchmark is based on inorganic mercury.
For lethality endpoints, Screening Benchmark = LC50 / 10
For cyanide, Screening Benchmark = Avoidance Conc / 100

Source: AQUIRE Database

Source Citations:

Birge, W.J. 1978. Aquatic Toxicology of Trace Elements of Coal and Fly Ash. In: J H Thorp and J W Gibbons (Eds.), Department of Energy Symposium Series, Energy and Environmental Stress in Aquatic Systems, Augusta, GA. 48:219-240.

Birge, W.J., J.E. Hudson, J.A. Black, and A.G. Westerman. 1979. Embryo-Larval Bioassays on Inorganic Coal Elements and in Situ Biomonitoring of Coal-Waste Effluents. In: Symposium US Fish & Wildlife Service, Surface Mining - Fish & Wildlife Needs in Eastern US, WV. 97-104.

Costa, H.H. 1965. Responses of Freshwater Animals to Sodium Cyanide Solutions III. Tadpoles of *Rana temporaria*. Ceylon J Sci Biol Sci 5(2):97-104.

Table 6-4
Phytotoxicity Benchmarks for Soil Exposures

Screening Ecological Risk Assessment for Richardson Flat Tailings

Analyte	CH2MHill, 1987a & CH2MHill, 1987b	Efroymson et al., 1997	Selected Phytotoxicity Benchmark (mg/kg dw)	
			Low	High
Aluminum	NA	50	50	NA
Antimony	NA	5	5	NA
Arsenic	100	10	10	100
Barium	NA	500	500	NA
Cadmium	100	4	4	100
Chromium	NA	1	1	NA
Copper	100	100	100	NA
Lead	1000	50	50	1000
Mercury	NA	35	35	NA
Selenium	NA	1	1	NA
Silver	2	2	2	NA
Zinc	500	50	50	500

All units are mg/kg dry weight.
NA = Not Available

Sources:

CH2MHill. 1987a. Assessment of the Toxicity of Arsenic, Cadmium, Lead and Zinc in Soil, Plants and Livestock in the Helena Valley of Montana for East Helena Site (ASARCO), East Helena, Montana.

CH2MHill. 1987b. Assessment of the Toxicity of Copper, Mercury, Selenium, Silver and Thallium in Soil, Plants and Livestock in the Helena Valley of Montana for East Helena Site (ASARCO), East Helena, Montana.

Efroymson et al., 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision.

Table 6-5
Phytotoxicity Benchmarks for Aqueous Exposures

Screening Ecological Risk Assessment for Richardson Flat Tailings

Analyte	Number of Literature Values	Confidence in Benchmark Value	Phytotoxicity Benchmark for Solutions (ug/L)
Aluminum	42	High	300
Arsenic	7	Low	1.0
Beryllium	11	Moderate	500
Boron	2	Low	1000
Cadmium	52	High	100
Chromium	14	Moderate	50
Cobalt	10	Low	60
Copper	17	Moderate	60
Lead	25	Moderate*	20
Manganese	19	Moderate	4000
Mercury	17	Moderate	5.0
Selenium	10	Low	700
Zinc	8	Low	400

NA = Not Available
* Decreased confidence based on lack of variety in test species.

Benchmark Confidence:
≤10 literature values = Low
11-20 literature values = Moderate
>20 literature values = High

Benchmark Derivation:
≤10 literature values = lowest LOEC
>10 literature values = 10th percentile LOEC

Source:

Efroymson, R. A., M. E. Will, G. W. Suter II, A. C. Wooten. 1997. *Toxicological Benchmarks for ScreeningContaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision.* Oak Ridge National Laboratory (ORNL). Prepared for the U.S. Department of Energy, Office of Environmental Management. November 1997.

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Table 6-6
Soil Fauna Toxicity Benchmarks for Soil Exposures

Screening Ecological Risk Assessment for Richardson Flat Tailings

Analyte	ORNL		CCME	RIVM	Selected Soil Invertebrate Benchmark (mg/kg dw)	
	Earthworm	Micro-organism			Low	High
Aluminum	NA	600	NA	NA	600	NA
Antimony	NA	NA	NA	NA	NA	NA
Arsenic	60	100	20	34	20	100
Barium	NA	3000	NA	NA	3000	NA
Cadmium	20	20	3	1.6	1.6	20
Chromium	0.4	10	NA	100	0.4	100
Copper	60	100	150	40	40	150
Lead	500	900	375	140	140	900
Mercury	0.1	30	0.8	0.67	0.1	30
Selenium	100	70	2	NA	2	100
Silver	NA	50	NA	NA	50	NA
Zinc	100	200	600	160	100	600

All units are mg/kg dry weight.
NA = Not Available

Source:

Oak Ridge National Laboratory (ORNL). Efroymson et al., 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision.

Canadian Council of Ministries of the Environment (CCME). 1997. Resommended Canadian Soil Quality Guidlines.

National Institute of Public Health and the Environment (Bilthoven, The Netherlands) (RIVM). 1997. Maximum Permissible Concentrations for metals, taking background concentrations into account.

Table 6-7
Uncertainty Factors Used in Deriving Wildlife TRVs

Screening Ecological Risk Assessment for Richardson Flat Tailings

Category	Basis for Uncertainty	Description	Uncertainty Factor
A	Inter-taxon Extrapolation	Same species	1
		Same genus, different species	2
		Same family, different genus	3
		Same order, different family	4
		Same class, different order	5
		Same phylum, different class	Do not use
B	Exposure Duration	Chronic study, approximately steady-state	1
		Subchronic studies, steady state not achieved	3
		Subacute studies (4-9 days for aquatic, 7-29 days for terrestrial)	5
		Acute studies (1-3 days for aquatic, 1-6 days for terrestrial)	10
		Peracute studies (less than 1 day, single dose)	15
C	Toxicological Endpoint	NOEL for non-lethal sensitive endpoint	0.75 to 1
		NOEL for lethality or severe endpoint	2
		NOAEL for non-lethal sensitive endpoint	1 to 2
		NOAEL for lethality or severe endpoint	3
		LOEL for non-lethal sensitive endpoint	2 to 3
		LOEL for lethality or severe endpoint	5
		LOAEL for non-lethal sensitive endpoint	3 to 5
		LOAEL for lethality or severe endpoint	10
		FEL for non-lethal sensitive endpoint	5 to 10
		FEL for lethality or severe endpoint	15
D	Modifying Factors	Endangered species Threatened species Listed species	2 1.5 1.25
		Relevance of toxicological endpoint to assessment endpoints	1 to 2
		Extrapolation from test conditions to site conditions	0.5 to 2
		Relevance of exposure medium and co-contaminants	0.5 to 2
		Relevance of mechanism to receptor of concern	1 to 2
		Sensitivity of test species compared to receptor of concern	0.5 to 2
		Reliability of methods used to estimate tissue levels	1 to 2
		Differences in age, gender, development	1 to 2
		Other factors	0.5 to 2

TRV = Study Dose / Total UF

Total UF = A · B · C · D, where A = $a_1 \cdot a_2 \cdot a_3 \cdot \ldots\ldots\ldots \cdot a_n$

Table 6-8
Summary of Ingestion TRVs for Wildlife Receptors

Screening Ecological Risk Assessment for Richardson Flats Tailings

		MAMMALIAN RECEPTORS							
		Deer Mouse		Mink		Masked Shrew		Red Fox	
Chemical	TRV	water	diet	water	diet	water	diet	water	diet
Aluminum	NOAEL	1.1	2.3	0.7	1.4	0.7	1.4	0.7	1.4
	LOAEL	5.5	11.0	3.3	6.6	3.3	6.6	3.3	6.6
Antimony	NOAEL	0.013	0.025	0.003	0.006	0.003	0.006	0.013	0.025
	LOAEL	0.038	0.075	0.009	0.019	0.009	0.019	0.038	0.075
Arsenic	NOAEL	1.3	2.5	0.3	0.2	0.3	0.1	0.3	0.2
	LOAEL	3.8	7.6	0.8	0.5	0.8	0.4	0.8	0.6
Barium	NOAEL	1.7	3.4	1.0	2.0	1.0	2.0	1.0	2.0
	LOAEL	5.1	10.1	3.0	6.1	3.0	6.1	3.0	6.1
Cadmium	NOAEL	0.8	0.8	0.2	0.5	0.2	0.5	0.2	0.5
	LOAEL	2.5	1.7	0.5	1.0	0.5	1.0	0.5	1.0
Chromium	NOAEL	667	1,333	400	800	400	800	400	800
	LOAEL	2,000	4,000	1,200	2,400	1,200	2,400	1,200	2,400
Cobalt	NOAEL	1.1	2.2	0.7	1.3	0.7	1.3	0.7	1.3
	LOAEL	3.3	6.7	2.0	4.0	2.0	4.0	2.0	4.0
Copper	NOAEL	3.8	168.0	17.7	8.8	0.8	33.6	4.4	2.2
	LOAEL	9.0	362.0	25.7	12.8	1.8	72.4	6.4	3.2
Lead	NOAEL	0.2	0.4	0.16	0.3	0.0	0.1	0.2	0.4
	LOAEL	0.6	1.3	0.31	0.6	0.1	0.3	0.4	0.8
Manganese	NOAEL	14.7	29.3	8.80	17.6	8.8	17.6	8.8	17.6
	LOAEL	47.3	94.7	28.40	56.8	28.4	56.8	28.4	56.8
Inorganic Mercury	NOAEL	3.3	6.6	0.7	1.4	1.3	2.6	0.2	0.3
	LOAEL	9.9	19.8	2.1	4.1	4.0	7.9	0.5	1.0
Organic Mercury	NOAEL	0.004	0.008	0.040	0.081	0.002	0.005	0.030	0.061
	LOAEL	0.019	0.038	0.066	0.132	0.011	0.023	0.050	0.099
Nickel	NOAEL	0.1	13.3	0.1	8.0	0.1	8.0	0.1	8.0
	LOAEL	0.4	40.0	0.3	24.0	0.3	24.0	0.3	24.0
Selenium	NOAEL	0.1	0.1	0.039	0.1	0.0	0.1	0.0	0.1
	LOAEL	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Thallium	NOAEL	0.002	0.003	0.001	0.002	0.001	0.002	0.001	0.002
	LOAEL	0.005	0.010	0.003	0.006	0.003	0.006	0.003	0.006
Vanadium	NOAEL	0.6	1.1	0.3	0.7	0.3	0.7	0.3	0.7
	LOAEL	1.7	3.3	1.0	2.0	1.0	2.0	1.0	2.0
Zinc	NOAEL	20	40	156	311	12	24	39	78
	LOAEL	40	80	467	933	24	48	117	233

All units in mg/kg BW/day

Table 6-8
Summary of Ingestion TRVs for Wildlife Receptors

Screening Ecological Risk Assessment for Richardson Flats Tailings

		AVIAN RECEPTORS									
		American Robin		American Kestrel		Belted Kingfisher		Mallard Duck		Greater-Sage Grouse	
Chemical	TRV	water	diet	water	diet	water	diet	water	diet	water	diet
Aluminum	NOAEL	3.5	7.0	3.5	7.0	3.5	7.0	3.5	7.0	3.5	7.0
	LOAEL	17.5	35.0	17.5	35.0	17.5	35.0	17.5	35.0	17.5	35.0
Antimony	NOAEL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	LOAEL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	NOAEL	0.4	0.8	0.4	0.8	0.4	0.8	0.4	0.8	0.4	0.8
	LOAEL	3.5	7.1	3.5	7.1	3.5	7.1	3.5	7.1	3.5	7.1
Barium	NOAEL	1.4	2.8	1.4	2.8	1.4	2.8	1.4	2.8	1.4	2.8
	LOAEL	2.8	5.6	2.8	5.6	2.8	5.6	2.8	5.6	2.8	5.6
Cadmium	NOAEL	0.04	0.09	0.04	0.09	0.04	0.09	0.04	0.09	0.04	0.09
	LOAEL	1.2	2.4	1.2	2.4	1.2	2.4	1.2	2.4	1.2	2.4
Chromium	NOAEL	0.10	0.20	0.10	0.20	0.10	0.20	0.10	0.20	0.10	0.20
	LOAEL	0.50	1.00	0.50	1.00	0.50	1.00	0.50	1.00	0.50	1.00
Cobalt	NOAEL	0.13	0.27	0.13	0.27	0.13	0.27	0.13	0.27	0.13	0.27
	LOAEL	0.27	0.53	0.27	0.53	0.27	0.53	0.27	0.53	0.27	0.53
Copper	NOAEL	2.0	4.0	2.0	4.0	2.0	4.0	2.0	4.0	2.0	4.0
	LOAEL	3.0	6.0	3.0	6.0	3.0	6.0	3.0	6.0	3.0	6.0
Lead	NOAEL	0.4	0.9	0.4	0.9	0.4	0.9	0.4	0.9	0.4	0.9
	LOAEL	0.9	1.8	0.9	1.8	0.9	1.8	0.9	1.8	0.9	1.8
Manganese	NOAEL	32.6	65.1	32.6	65.1	32.6	65.1	32.6	65.1	32.6	65.1
	LOAEL	97.7	195.4	97.7	195.4	97.7	195.4	97.7	195.4	97.7	195.4
Inorganic Mercury	NOAEL	0.05	0.09	0.05	0.09	0.05	0.09	0.05	0.09	0.05	0.09
	LOAEL	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2
Organic Mercury	NOAEL	0.023	0.045	0.023	0.045	0.023	0.045	0.023	0.045	0.023	0.045
	LOAEL	0.090	0.181	0.090	0.181	0.090	0.181	0.090	0.181	0.090	0.181
Nickel	NOAEL	2.58	5.16	2.58	5.16	2.58	5.16	2.58	5.16	2.58	5.16
	LOAEL	7.7	15.5	7.7	15.5	7.7	15.5	7.7	15.5	7.7	15.5
Selenium	NOAEL	0.05	0.10	0.05	0.10	0.05	0.10	0.05	0.10	0.05	0.10
	LOAEL	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2
Thallium	NOAEL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	LOAEL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NOAEL	1.1	2.3	1.1	2.3	1.1	2.3	1.1	2.3	1.1	2.3
	LOAEL	3.4	6.8	3.4	6.8	3.4	6.8	3.4	6.8	3.4	6.8
Zinc	NOAEL	13	26	13	26	13	26	13	26	13	26
	LOAEL	39	79	39	79	39	79	39	79	39	79

All units in mg/kg BW/day

Table 7-1

Surface Water Hazard Quotients (HQs) for Aquatic Receptors

Screening Ecological Risk Assessment for Richardson Flat Tailings

Station Information	Parameter	Surface Water EPC (ug/L) Total	Surface Water EPC (ug/L) Dissolved	Total Ambient Water Quality Criteria (ug/L) Acute	Total Ambient Water Quality Criteria (ug/L) Chronic	Dissolved Ambient Water Quality Criteria (ug/L) Acute	Dissolved Ambient Water Quality Criteria (ug/L) Chronic	Total HQ Acute	Total HQ Chronic	Dissolved HQ Acute	Dissolved HQ Chronic
	Aluminum	NA	29.1	750	87	750	87	NC	NC	4E-02	3E-01
Upstream Silver Creek	Arsenic	NA	3.3	340	150	340	150	NC	NC	1E-02	2E-02
	Cadmium	NA	3.3	7.8	0.5	7.0	0.4	NC	NC	5E-01	**8E+00**
492685	**Chromium**	**NA**	**3.3**	**16**	**11**	**5.1**	**9.5**	**NC**	**NC**	**6E-01**	**3E-01**
	Copper	NA	8	52	18	50	17	NC	NC	2E-01	5E-01
SILVER CK AT US40	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
XING E OF PARK CITY	Lead	NA	6	417	5	252	4	NC	NC	3E-02	**2E+00**
	Mercury	NA	0.10	1.4	0.8	1.2	0.7	NC	NC	8E-02	2E-01
Hardness 489 (mg/L)	**Selenium**	**NA**	**1.8**	**19**	**5.0**	**18**	**4.6**	**NC**	**NC**	**1E-01**	**4E-01**
	Silver	NA	1.0	35	NA	30	NA	NC	NC	3E-02	NC
	Zinc	**NA**	**1170**	**460**	**226**	**450**	**222**	**NC**	**NC**	**3E+00**	**5E+00**
	TOTAL HI							NC	NC	**4E+00**	**2E+01**
	Aluminum	NA	64.7	750	87	750	87	NC	NC	9E-02	7E-01
Upstream Silver Creek	Arsenic	NA	2.5	340	150	340	150	NC	NC	7E-03	2E-02
	Cadmium	NA	12.0	7.8	0.5	7.0	0.4	NC	NC	**2E+00**	**3E+01**
492695	**Chromium**	**NA**	**3.6**	**16**	**11**	**5.1**	**9.5**	**NC**	**NC**	**7E-01**	**4E-01**
SILVER CK @ CITY	Copper	NA	9	47	18	45	17	NC	NC	2E-01	5E-01
PARK AB PROSPECTOR	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
SQUARE	Lead	NA	5	417	5	252	4	NC	NC	2E-02	1E+00
	Mercury	NA	0.10	1.4	0.8	1.2	0.7	NC	NC	8E-02	2E-01
Hardness 361 (mg/L)	**Selenium**	**NA**	**2.0**	**19**	**5.0**	**18**	**4.6**	**NC**	**NC**	**1E-01**	**4E-01**
	Silver	NA	1.0	35	NA	30	NA	NC	NC	3E-02	NC
	Zinc	**NA**	**1011**	**355**	**226**	**347**	**222**	**NC**	**NC**	**3E+00**	**5E+00**
	TOTAL HI							NC	NC	**6E+00**	**4E+01**
	Aluminum	NA	NA	750	87	750	87	NC	NC	NC	NC
Upstream Silver Creek	Arsenic	NA	NA	340	150	340	150	NC	NC	NC	NC
	Cadmium	NA	NA	4.3	0.5	3.9	0.4	NC	NC	NC	NC
N4	**Chromium**	**NA**	**NA**	**16**	**11**	**5.1**	**9.5**	**NC**	**NC**	**NC**	**NC**
	Copper	390.00	NA	27	17	26	16	**1E+01**	**2E+01**	NC	NC
Silver Creek upstream of	Cyanide	6.44	NA	22	5.2	22	5.2	3E-01	1E+00	NC	NC
diversion ditch	Lead	1480.46	20	197	5	136	4	**8E+00**	**3E+02**	1E-01	**5E+00**
	Mercury	143.01	NA	1.4	0.8	1.2	0.7	**1E+02**	**2E+02**	NC	NC
Hardness 200 (mg/L)	**Selenium**	**NA**	**NA**	**19**	**5.0**	**18**	**4.6**	**NC**	**NC**	**NC**	**NC**
	Silver	NA	NA	13	NA	11	NA	NC	NC	NC	NC
	Zinc	**1350.04**	**560**	**216**	**216**	**211**	**213**	**6E+00**	**6E+00**	**3E+00**	**3E+00**
	TOTAL HI							**1E+02**	**5E+02**	**3E+00**	**8E+00**
	Aluminum	25.00	25.0	750	87	750	87	3E-02	3E-01	3E-02	3E-01
Upstream Silver Creek	Arsenic	10.00	7.0	340	150	340	150	3E-02	7E-02	2E-02	5E-02
	Cadmium	4.00	2.0	7.8	0.5	7.0	0.4	5E-01	**9E+00**	3E-01	**5E+00**
RF-7	**Chromium**	**7.50**	**7.5**	**16**	**11**	**5.1**	**9.5**	**5E-01**	**7E-01**	**1E+00**	**8E-01**
	Copper	13.00	4	52	18	50	17	3E-01	7E-01	8E-02	2E-01
Silver Creek upstream of	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
confluence with south	Lead	74.00	3	417	5	252	4	2E-01	**1E+01**	1E-02	6E-01
diversion ditch	Mercury	0.25	0.25	1.4	0.8	1.2	0.7	2E-01	3E-01	2E-01	4E-01
Hardness 432 (mg/L)	**Selenium**	**2.50**	**2.5**	**19**	**5.0**	**18**	**4.6**	**1E-01**	**5E-01**	**1E-01**	**5E-01**
	Silver	4.38	4.4	35	NA	30	NA	1E-01	NC	1E-01	NC
	Zinc	**96000.00**	**83000**	**414**	**226**	**405**	**222**	**2E+02**	**4E+02**	**2E+02**	**4E+02**
	TOTAL HI							**2E+02**	**5E+02**	**2E+02**	**4E+02**
	Aluminum	100.00	88.4	750	87	750	87	1E-01	1E+00	1E-01	1E+00
Upstream Silver Creek	Arsenic	13.00	8.2	340	150	340	150	4E-02	9E-02	2E-02	5E-02
	Cadmium	8.00	6.0	7.8	0.5	7.0	0.4	1E+00	**2E+01**	9E-01	**1E+01**
RF-7-2	**Chromium**	**3.00**	**6.0**	**16**	**11**	**5.1**	**9.5**	**2E-01**	**3E-01**	**1E+00**	**6E-01**
	Copper	7.73	6	52	18	50	17	1E-01	4E-01	1E-01	4E-01
Silver Creek upstream of	Cyanide	2.00	NA	22	5.2	22	5.2	9E-02	4E-01	NC	NC
confluence with south	Lead	78.00	5	417	5	252	4	2E-01	**1E+01**	2E-02	1E+00
diversion ditch	Mercury	0.24	0.22	1.4	0.8	1.2	0.7	2E-01	3E-01	2E-01	3E-01
Hardness 477 (mg/L)	**Selenium**	**4.69**	**2.3**	**19**	**5.0**	**18**	**4.6**	**2E-01**	**9E-01**	**1E-01**	**5E-01**
	Silver	12.58	3.8	35	NA	30	NA	4E-01	NC	1E-01	NC
	Zinc	**2100.00**	**2000**	**450**	**226**	**440**	**222**	**5E+00**	**9E+00**	**5E+00**	**9E+00**
	TOTAL HI							**7E+00**	**4E+01**	**7E+00**	**3E+01**
	Aluminum	20.30	NA	750	87	750	87	3E-02	2E-01	NC	NC
Upstream Silver Creek	Arsenic	4.20	NA	340	150	340	150	1E-02	3E-02	NC	NC
	Cadmium	3.90	NA	4.3	0.5	3.9	0.4	9E-01	**9E+00**	NC	NC
RF-SW-01	**Chromium**	**3.90**	**NA**	**16**	**11**	**5.1**	**9.5**	**2E-01**	**4E-01**	**NC**	**NC**
	Copper	10.00	NA	27	17	26	16	4E-01	6E-01	NC	NC
Silver Creek upstream of	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
diversion ditch	Lead	35.30	NA	197	5	136	4	2E-01	**7E+00**	NC	NC
	Mercury	0.10	NA	1.4	0.8	1.2	0.7	7E-02	1E-01	NC	NC
Hardness 200 (mg/L)	**Selenium**	**7.50**	**NA**	**19**	**5.0**	**18**	**4.6**	**4E-01**	**2E+00**	**NC**	**NC**
	Silver	1.20	NA	13	NA	11	NA	9E-02	NC	NC	NC
	Zinc	**1110.00**	**NA**	**216**	**216**	**211**	**213**	**5E+00**	**5E+00**	**NC**	**NC**
	TOTAL HI							**7E+00**	**2E+01**	**NC**	**NC**

Table 7-1

Surface Water Hazard Quotients (HQs) for Aquatic Receptors

Screening Ecological Risk Assessment for Richardson Flat Tailings

		Surface Water EPC (ug/L)		Total Ambient Water Quality Criteria (ug/L)		Dissolved Ambient Water Quality Criteria (ug/L)		Total HQ		Dissolved HQ	
Station Information	Parameter	Total	Dissolved	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic
	Aluminum	70.10	NA	750	87	750	87	9E-02	8E-01	NC	NC
Upstream Silver Creek	Arsenic	5.20	NA	340	150	340	150	2E-02	3E-02	NC	NC
	Cadmium	1.65	NA	4.3	0.5	3.9	0.4	4E-01	4E+00	NC	NC
RF-SW-02	Chromium	3.90	NA	16	11	5.1	9.5	2E-01	4E-01	NC	NC
	Copper	10.00	NA	27	17	26	16	4E-01	6E-01	NC	NC
Silver Creek upstream of	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
diversion ditch	Lead	18.80	NA	197	5	136	4	1E-01	3E+00	NC	NC
	Mercury	0.10	NA	1.4	0.8	1.2	0.7	7E-02	1E-01	NC	NC
Hardness 200 (mg/L)	Selenium	7.50	NA	19	5.0	18	4.6	4E-01	2E+00	NC	NC
	Silver	1.20	NA	13	NA	11	NA	9E-02	NC	NC	NC
	Zinc	2080.00	NA	216	216	211	213	1E+01	1E+01	NC	NC
	TOTAL HI							1E+01	2E+01	NC	NC
	Aluminum	19.30	NA	750	87	750	87	3E-02	2E-01	NC	NC
Upstream Silver Creek	Arsenic	7.30	NA	340	150	340	150	2E-02	5E-02	NC	NC
	Cadmium	1.65	NA	4.3	0.5	3.9	0.4	4E-01	4E+00	NC	NC
RF-SW-03	Chromium	3.90	NA	16	11	5.1	9.5	2E-01	4E-01	NC	NC
	Copper	10.00	NA	27	17	26	16	4E-01	6E-01	NC	NC
Silver Creek upstream of	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
diversion ditch	Lead	15.00	NA	197	5	136	4	8E-02	3E+00	NC	NC
	Mercury	0.10	NA	1.4	0.8	1.2	0.7	7E-02	1E-01	NC	NC
Hardness 200 (mg/L)	Selenium	7.50	NA	19	5.0	18	4.6	4E-01	2E+00	NC	NC
	Silver	1.20	NA	13	NA	11	NA	9E-02	NC	NC	NC
	Zinc	769.00	NA	216	216	211	213	4E+00	4E+00	NC	NC
	TOTAL HI							5E+00	1E+01	NC	NC
	Aluminum	65.50	NA	750	87	750	87	9E-02	8E-01	NC	NC
Upstream Silver Creek	Arsenic	7.60	NA	340	150	340	150	2E-02	5E-02	NC	NC
	Cadmium	3.50	NA	4.3	0.5	3.9	0.4	8E-01	8E+00	NC	NC
RF-SW-04	Chromium	3.90	NA	16	11	5.1	9.5	2E-01	4E-01	NC	NC
	Copper	10.00	NA	27	17	26	16	4E-01	6E-01	NC	NC
Silver Creek upstream of	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
diversion ditch	Lead	36.40	NA	197	5	136	4	2E-01	7E+00	NC	NC
	Mercury	0.10	NA	1.4	0.8	1.2	0.7	7E-02	1E-01	NC	NC
Hardness 200 (mg/L)	Selenium	7.50	NA	19	5.0	18	4.6	4E-01	2E+00	NC	NC
	Silver	1.20	NA	13	NA	11	NA	9E-02	NC	NC	NC
	Zinc	776.00	NA	216	216	211	213	4E+00	4E+00	NC	NC
	TOTAL HI							6E+00	2E+01	NC	NC
	Aluminum	69.00	170.0	750	87	750	87	9E-02	8E-01	2E-01	2E+00
Upstream Silver Creek	Arsenic	7.00	7.0	340	150	340	150	2E-02	5E-02	2E-02	5E-02
	Cadmium	3.00	1.0	7.8	0.5	7.0	0.4	4E-01	6E+00	1E-01	2E+00
USC-3	Chromium	5.00	5.0	16	11	5.1	9.5	3E-01	5E-01	1E+00	5E-01
Silver Creek at	Copper	7.00	3	52	18	50	17	1E-01	4E-01	5E-02	1E-01
Richardson Flats;	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
upstream of RR tressel	Lead	41.00	3	417	5	252	4	1E-01	8E+00	1E-02	6E-01
	Mercury	NA	NA	1.4	0.8	1.2	0.7	NC	NC	NC	NC
Hardness 454 (mg L)	Selenium	2.50	2.5	19	5.0	18	4.6	1E-01	5E-01	1E-01	5E-01
	Silver	2.50	2.5	35	NA	30	NA	7E-02	NC	8E-02	NC
	Zinc	1200.00	1100	432	226	423	222	3E+00	5E+00	3E+00	5E+00
	TOTAL HI							4E+00	2E+01	4E+00	1E+01
	Aluminum	25.00	25.0	750	87	750	87	3E-02	3E-01	3E-02	3E-01
Upstream Silver Creek	Arsenic	2.50	5.0	340	150	340	150	7E-03	2E-02	1E-02	3E-02
	Cadmium	6.00	1.0	7.8	0.5	7.0	0.4	8E-01	1E+01	1E-01	2E+00
USC-5	Chromium	5.00	5.0	16	11	5.1	9.5	3E-01	5E-01	1E+00	5E-01
Silver Creek above	Copper	9.00	7	52	18	50	17	2E-01	5E-01	1E-01	4E-01
Richardson Flats; at old	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
north road to site	Lead	26.00	3	417	5	252	4	6E-02	5E+00	1E-02	6E-01
	Mercury	NA	NA	1.4	0.8	1.2	0.7	NC	NC	NC	NC
Hardness 464 (mg/L)	Selenium	2.50	2.5	19	5.0	18	4.6	1E-01	5E-01	1E-01	5E-01
	Silver	2.50	2.5	35	NA	30	NA	7E-02	NC	8E-02	NC
	Zinc	1900.00	2000	439	226	430	222	4E+00	8E+00	5E+00	9E+00
	TOTAL HI							6E+00	3E+01	6E+00	1E+01
	Aluminum	25.00	25.0	750	87	750	87	3E-02	3E-01	3E-02	3E-01
Upstream Silver Creek	Arsenic	19.00	8.0	340	150	340	150	6E-02	1E-01	2E-02	5E-02
	Cadmium	2.00	2.0	7.8	0.5	7.0	0.4	3E-01	4E+00	3E-01	5E+00
USC-6	Chromium	5.00	5.0	16	11	5.1	9.5	3E-01	5E-01	1E+00	5E-01
	Copper	6.00	3	52	18	50	17	1E-01	3E-01	5E-02	1E-01
Silver Creek below Silver	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
Maple Claims	Lead	31.00	3	417	5	252	4	7E-02	6E+00	1E-02	6E-01
	Mercury	0.04	0.004	1.4	0.8	1.2	0.7	3E-02	5E-02	3E-03	6E-03
Hardness 480 (mg/L)	Selenium	2.50	2.5	19	5.0	18	4.6	1E-01	5E-01	1E-01	5E-01
	Silver	2.50	2.5	35	NA	30	NA	7E-02	NC	8E-02	NC
	Zinc	1400.00	1400	453	226	443	222	3E+00	6E+00	3E+00	6E+00
	TOTAL HI							4E+00	2E+01	5E+00	1E+01

Table 7-1

Surface Water Hazard Quotients (HQs) for Aquatic Receptors

Screening Ecological Risk Assessment for Richardson Flat Tailings

Station Information	Parameter	Surface Water EPC (ug/L)		Total Ambient Water Quality Criteria (ug/L)		Dissolved Ambient Water Quality Criteria (ug/L)		Total HQ		Dissolved HQ	
		Total	Dissolved	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic
	Aluminum	710.00	25.0	750	87	750	87	9E-01	8E+00	3E-02	3E-01
Upstream Silver Creek	Arsenic	2.50	5.0	340	150	340	150	7E-03	2E-02	1E-02	3E-02
	Cadmium	10.00	7.0	7.8	0.47	7.0	0.41	1E+00	2E+01	1E+00	2E+01
USC-7	Chromium	4.38	4.4	16	11	5.1	9.5	3E-01	4E-01	9E-01	5E-01
	Copper	18.00	12	47	18	45	17	4E-01	1E+00	3E-01	7E-01
Silver Creek above Silver	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
Maple Claims	Lead	27.00	2	417	5	252	4	6E-02	5E+00	9E-03	6E-01
	Mercury	0.05	0.004	1.4	0.8	1.2	0.7	4E-02	7E-02	3E-03	6E-03
Hardness 361 (mg/L)	Selenium	2.50	2.5	19	5.0	18	4.6	1E-01	5E-01	1E-01	5E-01
	Silver	2.13	2.1	35	NA	30	NA	6E-02	NC	7E-02	NC
	Zinc	2500.00	2100	355	226	347	222	7E+00	1E+01	6E+00	9E+00
	TOTAL HI							1E+01	5E+01	8E+00	3E+01
Downstream Silver	Aluminum	50.00	15.0	750	87	750	87	7E-02	6E-01	2E-02	2E-01
Creek	Arsenic	8.70	12.0	340	150	340	150	3E-02	6E-02	4E-02	8E-02
	Cadmium	0.50	0.5	7.8	0.47	7.0	0.41	6E-02	1E+00	7E-02	1E+00
492679	Chromium	5.80	2.5	16	11	5.1	9.5	4E-01	5E-01	5E-01	3E-01
	Copper	6.00	6	52	18	50	17	1E-01	3E-01	1E-01	4E-01
SILVER CREEK WWTP	Cyanide	5.00	NA	22	5.2	22	5.2	2E-01	1E+00	NC	NC
	Lead	1.50	2	417	5	252	4	4E-03	3E-01	6E-03	4E-01
	Mercury	0.10	0.10	1.4	0.8	1.2	0.7	7E-02	1E-01	8E-02	2E-01
Hardness 581 (mg/L)	Selenium	0.50	1.2	19	5.0	18	4.6	3E-02	1E-01	7E-02	3E-01
	Silver	1.00	1.0	35	NA	30	NA	3E-02	NC	3E-02	NC
	Zinc	170.00	330	469	226	458	222	4E-01	8E-01	7E-01	1E+00
	TOTAL HI							1E+00	5E+00	2E+00	4E+00
Downstream Silver	Aluminum	NA	15.0	750	87	750	87	NC	NC	2E-02	2E-01
Creek	Arsenic	NA	7.6	340	150	340	150	NC	NC	2E-02	5E-02
	Cadmium	NA	1.1	7.8	0.47	7.0	0.41	NC	NC	2E-01	3E+00
492680	Chromium	NA	2.5	16	11	5.1	9.5	NC	NC	5E-01	3E-01
	Copper	NA	6	52	18	50	17	NC	NC	1E-01	4E-01
SILVER CK AB	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
ATKINSON	Lead	NA	10	417	5	252	4	NC	NC	4E-02	2E+00
	Mercury	NA	0.10	1.4	0.8	1.2	0.7	NC	NC	8E-02	2E-01
Hardness 462 (mg/L)	Selenium	NA	1.2	19	5.0	18	4.6	NC	NC	7E-02	3E-01
	Silver	NA	1.0	35	NA	30	NA	NC	NC	3E-02	NC
	Zinc	NA	765	438	226	428	222	NC	NC	2E+00	3E+00
	TOTAL HI							NC	NC	3E+00	1E+01
Downstream Silver	Aluminum	NA	NA	750	87	750	87	NC	NC	NC	NC
Creek	Arsenic	NA	NA	340	150	340	150	NC	NC	NC	NC
	Cadmium	NA	NA	4.3	0.45	3.9	0.40	NC	NC	NC	NC
N6	Chromium	NA	NA	16	11	5.1	9.5	NC	NC	NC	NC
	Copper	10.24	NA	27	17	26	16	4E-01	6E-01	NC	NC
Silver Creek downstream	Cyanide	2.65	NA	22	5.2	22	5.2	1E-01	5E-01	NC	NC
of diversion ditch	Lead	145.34	25	197	5	136	4	7E-01	3E+01	2E-01	6E+00
	Mercury	133.06	NA	1.4	0.8	1.2	0.7	1E+02	2E+02	NC	NC
Hardness 200 (mg/L)	Selenium	NA	NA	19	5.0	18	4.6	NC	NC	NC	NC
	Silver	NA	NA	13	NA	11	NA	NC	NC	NC	NC
	Zinc	901.51	370	216	216	211	213	4E+00	4E+00	2E+00	2E+00
	TOTAL HI							1E+02	2E+02	2E+00	8E+00
Downstream Silver	Aluminum	330.00	33.3	750	87	750	87	4E-01	4E+00	4E-02	4E-01
Creek	Arsenic	31.00	8.2	340	150	340	150	9E-02	2E-01	2E-02	5E-02
	Cadmium	9.00	2.1	7.8	0.47	7.0	0.41	1E+00	2E+01	3E-01	5E+00
RF-8	Chromium	4.00	8.7	16	11	5.1	9.5	3E-01	4E-01	2E+00	9E-01
Silver Creek downstream	Copper	10.43	4	52	18	50	17	2E-01	6E-01	8E-02	2E-01
of confluence with south	Cyanide	2.00	NA	22	5.2	22	5.2	9E-02	4E-01	NC	NC
diversion ditch	Lead	340.00	6	417	5	252	4	8E-01	6E+01	2E-02	1E+00
	Mercury	0.35	0.22	1.4	0.8	1.2	0.7	2E-01	5E-01	2E-01	3E-01
Hardness 495 (mg L)	Selenium	5.00	2.4	19	5.0	18	4.6	3E-01	1E+00	1E-01	5E-01
	Silver	4.95	3.9	35	NA	30	NA	1E-01	NC	1E-01	NC
	Zinc	1700.00	1100	464	226	454	222	4E+00	8E+00	2E+00	5E+00
	TOTAL HI							7E+00	1E+02	5E+00	1E+01
Downstream Silver	Aluminum	NA	NA	750	87	750	87	NC	NC	NC	NC
Creek	Arsenic	10.00	10.0	340	150	340	150	3E-02	7E-02	3E-02	7E-02
	Cadmium	3.00	2.0	4.3	0.45	3.9	0.40	7E-01	7E+00	5E-01	5E+00
RF-8-2	Chromium	10.00	10.0	16	11	5.1	9.5	6E-01	9E-01	2E+00	1E+00
Silver Creek downstream	Copper	5.00	5	27	17	26	16	2E-01	3E-01	2E-01	3E-01
of confluence with south	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
diversion ditch	Lead	28.00	3	197	5	136	4	1E-01	5E+00	2E-02	6E-01
	Mercury	0.25	0.25	1.4	0.8	1.2	0.7	2E-01	3E-01	2E-01	4E-01
Hardness 200 (mg/L)	Selenium	2.50	2.5	19	5.0	18	4.6	1E-01	5E-01	1E-01	5E-01
	Silver	5.00	5.0	13	NA	11	NA	4E-01	NC	4E-01	NC
	Zinc	850.00	850	216	216	211	213	4E+00	4E+00	4E+00	4E+00
	TOTAL HI							6E+00	2E+01	8E+00	1E+01

Table 7-1

Surface Water Hazard Quotients (HQs) for Aquatic Receptors

Screening Ecological Risk Assessment for Richardson Flat Tailings

Station Information	Parameter	Surface Water EPC (ug/L) Total	Surface Water EPC (ug/L) Dissolved	Total Ambient Water Quality Criteria (ug/L) Acute	Total Ambient Water Quality Criteria (ug/L) Chronic	Dissolved Ambient Water Quality Criteria (ug/L) Acute	Dissolved Ambient Water Quality Criteria (ug/L) Chronic	Total HQ Acute	Total HQ Chronic	Dissolved HQ Acute	Dissolved HQ Chronic
Downstream Silver	Aluminum	8.55	NA	750	87	750	87	1E-02	1E-01	NC	NC
Creek	Arsenic	7.20	NA	340	150	340	150	2E-02	5E-02	NC	NC
	Cadmium	1.65	NA	4.3	0.45	3.9	0.40	4E-01	4E+00	NC	NC
RF-SW-05	Chromium	3.90	NA	16	11	5.1	9.5	2E-01	4E-01	NC	NC
	Copper	10.00	NA	27	17	26	16	4E-01	6E-01	NC	NC
Silver Creek downstream	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
of diversion ditch	Lead	151.00	NA	197	5	136	4	8E-01	3E+01	NC	NC
	Mercury	0.10	NA	1.4	0.8	1.2	0.7	7E-02	1E-01	NC	NC
Hardness 200 (mg/L)	Selenium	7.50	NA	19	5.0	18	4.6	4E-01	2E+00	NC	NC
	Silver	1.20	NA	13	NA	11	NA	9E-02	NC	NC	NC
	Zinc	466.00	NA	216	216	211	213	2E+00	2E+00	NC	NC
	TOTAL HI							5E+00	4E+01	NC	NC
Downstream Silver	Aluminum	185.00	NA	750	87	750	87	2E-01	2E+00	NC	NC
Creek	Arsenic	12.50	NA	340	150	340	150	4E-02	8E-02	NC	NC
	Cadmium	1.65	NA	4.3	0.45	3.9	0.40	4E-01	4E+00	NC	NC
RF-SW-06	Chromium	3.90	NA	16	11	5.1	9.5	2E-01	4E-01	NC	NC
	Copper	10.00	NA	27	17	26	16	4E-01	6E-01	NC	NC
Silver Creek downstream	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
of diversion ditch	Lead	33.20	NA	197	5	136	4	2E-01	6E+00	NC	NC
	Mercury	0.10	NA	1.4	0.8	1.2	0.7	7E-02	1E-01	NC	NC
Hardness 200 (mg/L)	Selenium	7.50	NA	19	5.0	18	4.6	4E-01	2E+00	NC	NC
	Silver	10.00	NA	13	NA	11	NA	7E-01	NC	NC	NC
	Zinc	321.00	NA	216	216	211	213	1E+00	1E+00	NC	NC
	TOTAL HI							4E+00	2E+01	NC	NC
Downstream Silver	Aluminum	350.00	25.0	750	87	750	87	5E-01	4E+00	3E-02	3E-01
Creek	Arsenic	6.00	6.0	340	150	340	150	2E-02	4E-02	2E-02	4E-02
	Cadmium	2.00	1.8	7.8	0.47	7.0	0.41	3E-01	4E+00	3E-01	4E+00
USC-1	Chromium	5.00	5.0	16	11	5.1	9.5	3E-01	5E-01	1E+00	5E-01
	Copper	12.00	3	52	18	50	17	2E-01	7E-01	5E-02	1E-01
Silver Creek below	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
Richardson Flat; at U248	Lead	51.00	3	417	5	252	4	1E-01	9E+00	1E-02	6E-01
rail tressel	Mercury	0.11	0.002	1.4	0.8	1.2	0.7	8E-02	1E-01	2E-03	4E-03
Hardness 521 (mg/L)	Selenium	2.50	2.5	19	5.0	18	4.6	1E-01	5E-01	1E-01	5E-01
	Silver	2.50	2.5	35	NA	30	NA	7E-02	NC	8E-02	NC
	Zinc	1100.00	1000	469	226	458	222	2E+00	5E+00	2E+00	4E+00
	TOTAL HI							4E+00	2E+01	4E+00	1E+01
Downstream Silver	Aluminum	25.00	25.0	750	87	750	87	3E-02	3E-01	3E-02	3E-01
Creek	Arsenic	2.50	7.0	340	150	340	150	7E-03	2E-02	2E-02	5E-02
	Cadmium	2.00	1.5	7.8	0.47	7.0	0.41	3E-01	4E+00	2E-01	4E+00
USC-2	Chromium	5.00	5.0	16	11	5.1	9.5	3E-01	5E-01	1E+00	5E-01
	Copper	2.50	3	52	18	50	17	5E-02	1E-01	5E-02	1E-01
Silver Creek below	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
Richardson Flat; at U248	Lead	16.00	12	417	5	252	4	4E-02	3E+00	5E-02	3E+00
culvert	Mercury	NA	NA	1.4	0.8	1.2	0.7	NC	NC	NC	NC
Hardness 510 (mg/L)	Selenium	2.50	2.5	19	5.0	18	4.6	1E-01	5E-01	1E-01	5E-01
	Silver	7.00	2.5	35	NA	30	NA	2E-01	NC	8E-02	NC
	Zinc	630.00	710	469	226	458	222	1E+00	3E+00	2E+00	3E+00
	TOTAL HI							2E+00	1E+01	3E+00	1E+01
	Aluminum	NA	NA	750	87	750	87	NC	NC	NC	NC
Site Diversion Ditch	Arsenic	NA	NA	340	150	340	150	NC	NC	NC	NC
	Cadmium	NA	NA	4.3	0.45	3.9	0.40	NC	NC	NC	NC
N5	Chromium	NA	NA	16	11	5.1	9.5	NC	NC	NC	NC
	Copper	10.87	NA	27	17	26	16	4E-01	6E-01	NC	NC
Diversion Ditch	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
	Lead	44.61	NA	197	5	136	4	2E-01	8E+00	NC	NC
	Mercury	0.20	NA	1.4	0.8	1.2	0.7	1E-01	3E-01	NC	NC
Hardness 200 (mg L)	Selenium	NA	NA	19	5.0	18	4.6	NC	NC	NC	NC
	Silver	NA	NA	13	NA	11	NA	NC	NC	NC	NC
	Zinc	918.35	NA	216	216	211	213	4E+00	4E+00	NC	NC
	TOTAL HI							5E+00	1E+01	NC	NC
	Aluminum	580.00	190.0	750	87	750	87	8E-01	7E+00	3E-01	2E+00
Site Diversion Ditch	Arsenic	5.00	6.0	340	150	340	150	1E-02	3E-02	2E-02	4E-02
	Cadmium	0.50	0.5	4.2	0.44	3.8	0.39	1E-01	1E+00	1E-01	1E+00
RF-2	Chromium	7.50	7.5	16	11	5.1	9.5	5E-01	7E-01	1E+00	8E-01
	Copper	18.00	16	26	16	25	16	7E-01	1E+00	6E-01	1E+00
South diversion ditch	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
	Lead	5.00	5	188	5	131	4	3E-02	9E-01	4E-02	1E+00
	Mercury	0.28	0.20	1.4	0.8	1.2	0.7	2E-01	4E-01	2E-01	3E-01
Hardness 193 (mg/L)	Selenium	2.25	2.3	19	5.0	18	4.6	1E-01	5E-01	1E-01	5E-01
	Silver	3.75	3.8	13	NA	11	NA	3E-01	NC	4E-01	NC
	Zinc	94.00	79	209	209	204	206	5E-01	5E-01	4E-01	4E-01
	TOTAL HI							3E+00	1E+01	4E+00	8E+00

Table 7-1

Surface Water Hazard Quotients (HQs) for Aquatic Receptors

Screening Ecological Risk Assessment for Richardson Flat Tailings

Station Information	Parameter	Surface Water EPC (ug/L)		Total Ambient Water Quality Criteria (ug/L)		Dissolved Ambient Water Quality Criteria (ug/L)		Total HQ		Dissolved HQ	
		Total	Dissolved	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic
	Aluminum	480.00	60.8	750	87	750	87	6E-01	6E+00	8E-02	7E-01
Site Diversion Ditch	Arsenic	8.00	8.0	340	150	340	150	2E-02	5E-02	2E-02	5E-02
	Cadmium	2.00	0.5	7.8	0.47	7.0	0.41	3E-01	4E+00	7E-02	1E+00
RF-4	Chromium	0.05	6.1	16	11	5.1	9.5	3E-03	4E-03	1E+00	6E-01
	Copper	17.00	11	52	18	50	17	3E-01	1E+00	2E-01	7E-01
South diversion ditch	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
	Lead	2.50	4	417	5	252	4	6E-03	5E-01	1E-02	9E-01
	Mercury	0.35	0.20	1.4	0.8	1.2	0.7	2E-01	4E-01	2E-01	3E-01
Hardness 733 (mg/L)	Selenium	2.17	2.2	19	5.0	18	4.6	1E-01	4E-01	1E-01	5E-01
	Silver	3.33	3.3	35	NA	30	NA	1E-01	NC	1E-01	NC
	Zinc	2700.00	2600	469	226	458	222	6E+00	1E+01	6E+00	1E+01
	TOTAL HI							7E+00	2E+01	8E+00	2E+01
	Aluminum	340.00	44.9	750	87	750	87	5E-01	4E+00	6E-02	5E-01
Site Diversion Ditch	Arsenic	6.00	5.0	340	150	340	150	2E-02	4E-02	1E-02	3E-02
	Cadmium	1.00	0.5	7.8	0.47	7.0	0.41	1E-01	2E+00	7E-02	1E+00
RF-5	Chromium	0.04	6.0	16	11	5.1	9.5	3E-03	4E-03	1E+00	6E-01
	Copper	12.13	9	52	18	50	17	2E-01	7E-01	2E-01	5E-01
South diversion ditch	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
	Lead	9.00	3	417	5	252	4	2E-02	2E+00	1E-02	6E-01
	Mercury	0.26	0.22	1.4	0.8	1.2	0.7	2E-01	3E-01	2E-01	3E-01
Hardness 864 (mg/L)	Selenium	0.00	2.2	19	5.0	18	4.6	2E-04	8E-04	1E-01	5E-01
	Silver	9.86	3.6	35	NA	30	NA	3E-01	NC	1E-01	NC
	Zinc	900.00	860	469	226	458	222	2E+00	4E+00	2E+00	4E+00
	TOTAL HI							3E+00	1E+01	4E+00	8E+00
	Aluminum	470.00	69.0	750	87	750	87	6E-01	5E+00	9E-02	8E-01
Site Diversion Ditch	Arsenic	8.00	7.0	340	150	340	150	2E-02	5E-02	2E-02	5E-02
	Cadmium	2.00	0.5	7.8	0.47	7.0	0.41	3E-01	4E+00	7E-02	1E+00
RF-5-4	Chromium	5.00	5.0	16	11	5.1	9.5	3E-01	5E-01	1E+00	5E-01
	Copper	18.00	17	52	18	50	17	3E-01	1E+00	3E-01	1E+00
South diversion ditch	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
	Lead	2.50	3	417	5	252	4	6E-03	5E-01	1E-02	6E-01
	Mercury	0.24	0.22	1.4	0.8	1.2	0.7	2E-01	3E-01	2E-01	3E-01
Hardness 450 (mg/L)	Selenium	2.00	2.0	19	5.0	18	4.6	1E-01	4E-01	1E-01	4E-01
	Silver	2.50	2.5	35	NA	30	NA	7E-02	NC	8E-02	NC
	Zinc	2600.00	2500	428	226	419	222	6E+00	1E+01	6E+00	1E+01
	TOTAL HI							8E+00	2E+01	8E+00	2E+01
	Aluminum	NA	NA	750	87	750	87	NC	NC	NC	NC
Site Diversion Ditch	Arsenic	6.00	6.0	340	150	340	150	2E-02	4E-02	2E-02	4E-02
	Cadmium	2.02	1.7	7.8	0.47	7.0	0.41	3E-01	4E+00	2E-01	4E+00
RF-6	Chromium	4.00	10.0	16	11	5.1	9.5	3E-01	4E-01	2E+00	1E+00
	Copper	5.00	5	52	18	50	17	1E-01	3E-01	1E-01	3E-01
South diversion ditch	Cyanide	2.00	NA	22	5.2	22	5.2	9E-02	4E-01	NC	NC
	Lead	48.00	3	417	5	252	4	1E-01	9E+00	1E-02	6E-01
	Mercury	0.23	0.25	1.4	0.8	1.2	0.7	2E-01	3E-01	2E-01	4E-01
Hardness 587 (mg/L)	Selenium	3.73	2.6	19	5.0	18	4.6	2E-01	7E-01	1E-01	6E-01
	Silver	4.50	4.4	35	NA	30	NA	1E-01	NC	1E-01	NC
	Zinc	850.00	850	469	226	458	222	2E+00	4E+00	2E+00	4E+00
	TOTAL HI							3E+00	2E+01	5E+00	1E+01
	Aluminum	164.57	32.5	750	87	750	87	2E-01	2E+00	4E-02	4E-01
Site Diversion Ditch	Arsenic	750.00	3.9	340	150	340	150	2E+00	5E+00	1E-02	3E-02
	Cadmium	0.00	0.6	7.8	0.47	7.0	0.41	3E-04	4E-03	9E-02	2E+00
RF-6-2	Chromium	0.04	6.8	16	11	5.1	9.5	2E-03	4E-03	1E+00	7E-01
	Copper	9.97	7	52	18	50	17	2E-01	6E-01	1E-01	4E-01
South diversion ditch	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
	Lead	16.00	4	417	5	252	4	4E-02	3E+00	1E-02	9E-01
	Mercury	0.32	0.002	1.4	0.8	1.2	0.7	2E-01	4E-01	2E-03	3E-03
Hardness 1068 (mg/L)	Selenium	5.87	2.1	19	5.0	18	4.6	3E-01	1E+00	1E-01	5E-01
	Silver	4.80	3.4	35	NA	30	NA	1E-01	NC	1E-01	NC
	Zinc	310.00	150	469	226	458	222	7E-01	1E+00	3E-01	7E-01
	TOTAL HI							4E+00	1E+01	2E+00	5E+00
	Aluminum	25.00	25.0	750	87	750	87	3E-02	3E-01	3E-02	3E-01
Site Diversion Ditch	Arsenic	6.00	2.5	340	150	340	150	2E-02	4E-02	7E-03	2E-02
	Cadmium	1.83	1.8	7.8	0.47	7.0	0.41	2E-01	4E+00	3E-01	4E+00
USC-4	Chromium	5.00	36.0	16	11	5.1	9.5	3E-01	5E-01	7E+00	4E+00
	Copper	6.00	3	52	18	50	17	1E-01	3E-01	5E-02	1E-01
Richardson Flats	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
diversion ditch 50'	Lead	11.00	3	417	5	252	4	3E-02	2E+00	1E-02	6E-01
	Mercury	0.002	0.001	1.4	0.8	1.2	0.7	1E-03	3E-03	1E-03	2E-03
Hardness 999 (mg L)	Selenium	2.50	2.5	19	5.0	18	4.6	1E-01	5E-01	1E-01	5E-01
	Silver	2.50	2.5	35	NA	30	NA	7E-02	NC	8E-02	NC
	Zinc	110.00	100	469	226	458	222	2E-01	5E-01	2E-01	4E-01
	TOTAL HI							1E+00	8E+00	8E+00	1E+01

Table 7-1

Surface Water Hazard Quotients (HQs) for Aquatic Receptors

Screening Ecological Risk Assessment for Richardson Flat Tailings

Station Information	Parameter	Surface Water EPC (ug/L)		Total Ambient Water Quality Criteria (ug/L)		Dissolved Ambient Water Quality Criteria (ug/L)		Total HQ		Dissolved HQ	
		Total	Dissolved	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic
	Aluminum	NA	NA	750	87	750	87	NC	NC	NC	NC
Site Ponded Water	Arsenic	10.00	10.0	340	150	340	150	3E-02	7E-02	3E-02	7E-02
	Cadmium	0.50	0.5	6.2	0.47	5.6	0.41	8E-02	1E+00	9E-02	1E+00
RF-9	**Chromium**	**10.00**	**10.0**	**16**	**11**	**5.1**	**9.5**	**6E-01**	**9E-01**	**2E+00**	**1E+00**
	Copper	5.00	5	38	18	36	17	1E-01	3E-01	1E-01	3E-01
Ponded water on the	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
tailings impoundment	Lead	2.50	3	313	5	199	4	8E-03	5E-01	1E-02	6E-01
	Mercury	0.25	0.25	1.4	0.8	1.2	0.7	2E-01	3E-01	2E-01	4E-01
Hardness 287 (mg/L)	**Selenium**	**2.50**	**2.5**	**19**	**5.0**	**18**	**4.6**	**1E-01**	**5E-01**	**1E-01**	**5E-01**
	Silver	5.00	5.0	25	NA	21	NA	2E-01	NC	2E-01	NC
	Zinc	**11.00**	**29**	**293**	**226**	**286**	**222**	**4E-02**	**5E-02**	**1E-01**	**1E-01**
	TOTAL HI							1E+00	**4E+00**	**3E+00**	**4E+00**
Unnamed Drainages - Background	Aluminum	NA	NA	750	87	750	87	NC	NC	NC	NC
	Arsenic	NA	NA	340	150	340	150	NC	NC	NC	NC
	Cadmium	NA	NA	4.3	0.45	3.9	0.40	NC	NC	NC	NC
RF-1	**Chromium**	**NA**	**NA**	**16**	**11**	**5.1**	**9.5**	**NC**	**NC**	**NC**	**NC**
Unnamed drainage	Copper	NA	NA	27	17	26	16	NC	NC	NC	NC
flowing into the south	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
diversion ditch	Lead	NA	NA	197	5	136	4	NC	NC	NC	NC
	Mercury	0.01	0.004	1.4	0.8	1.2	0.7	5E-03	9E-03	4E-03	7E-03
Hardness 200 (mg/L)	**Selenium**	**NA**	**NA**	**19**	**5.0**	**18**	**4.6**	**NC**	**NC**	**NC**	**NC**
	Silver	NA	NA	13	NA	11	NA	NC	NC	NC	NC
	Zinc	**NA**	**NA**	**216**	**216**	**211**	**213**	**NC**	**NC**	**NC**	**NC**
	TOTAL HI							**5E-03**	**9E-03**	**4E-03**	**7E-03**
Unnamed Drainages - Background	Aluminum	1400.00	89.0	750	87	750	87	**2E+00**	**2E+01**	1E-01	1E+00
	Arsenic	17.00	10.0	340	150	340	150	5E-02	1E-01	3E-02	7E-02
	Cadmium	0.01	0.0	7.1	0.47	6.4	0.41	1E-03	1E-02	2E-04	2E-03
RF-3-2	**Chromium**	**0.04**	**5.0**	**16**	**11**	**5.1**	**9.5**	**2E-03**	**4E-03**	**1E+00**	**5E-01**
Background - Unnamed	Copper	22.00	20	43	18	41	17	5E-01	1E+00	5E-01	1E+00
drainage flowing into the	Cyanide	NA	NA	22	5.2	22	5.2	NC	NC	NC	NC
south diversion ditch	Lead	7.00	5	370	5	229	4	2E-02	1E+00	2E-02	1E+00
	Mercury	0.24	0.22	1.4	0.8	1.2	0.7	2E-01	3E-01	2E-01	3E-01
Hardness 328 (mg/L)	**Selenium**	**2.00**	**2.0**	**19**	**5.0**	**18**	**4.6**	**1E-01**	**4E-01**	**1E-01**	**4E-01**
	Silver	2.50	2.5	31	NA	27	NA	8E-02	NC	9E-02	NC
	Zinc	**98.00**	**77**	**328**	**226**	**321**	**222**	**3E-01**	**4E-01**	**2E-01**	**3E-01**
	TOTAL HI							**3E+00**	**2E+01**	**2E+00**	**5E+00**

NA = Not Available
NC = Not Calculated

Mean concentrations are calculated using 1/2 the detection limit for non-detects "U".
If station-specific hardness is not available, a station hardness of 200 mg/L is assumed.
If hardness is greater than AWQC upper hardness limit, the upper hardness limit is used to calulate the AWQC.
HQs in exceedance of the benchmark are shown in boldface type.

Table 7-2
Summary of Species-Mean Toxicity Reference Values for Fish

Screening Ecological Risk Assessment for Richardson Flat Tailings

Species	TRV	Cadmium	Lead	Zinc
Brook trout (*Salvelinus fontinalis)*	SMAV	3.13	9,214	3,695
Northern squawfish (*Ptychockeilus oregonensis)*	SMAV	4586	na	11,578
Rainbow trout (*Oncorhynchus mykiss)*	SMAV	11	4,680	1,213
White sucke, (*Catostomus commersoni)*	SMAV	6715	na	9,199
Brook trout (*Salvelinus fontinalis)*	SMCV	3.55	187	1,617
Rainbow trout (O*ncorhynchus mykiss)*	SMCV	na	152	1,272

All values are based on data given in EPA 1985 b-e, 1987, 1996.
SMAV = Species Mean Acute Value
SMCV = Species Mean Chronic Value
All values are adjusted to a hardness of 100 mg/L.
na = Not Available

Table 7-3
Summary of Genus-Mean Toxicity Reference Values for Aquatic Macroinvertebrates

Screening Ecological Risk Assessment for Richardson Flat Tailings

Species	TRV	Cadmium	Lead	Zinc
Amphipod, *Gammarus* sp.	GMAV	155	272.6	14,252
Cladoceran, *Daphnia* sp.	GMAV	44	856.0	528
Midge	GMAV	2477	450,952	na
Snail	GMAV	817	1,988	2,506
Tubificid worm	GMAV	9180	na	2,224
Caddisfly	GMCV	na	na	13,832
Cladoceran, *Daphnia* sp.	GMCV	1.4	56.01	91
Snail	GMCV	8.1	15	na

All values are based on data given in EPA 1985 b-e, 1987, 1996.
GMAV = Genus Mean Acute Value
GMCV = Genus Mean Chronic Value
Where shaded, the species mean value is presented.
All values are adjusted to a hardness of 100 mg/L.
na = Not Available

Table 7-4

Sediment Hazard Quotients (HQs) for Aquatic Receptors

Screening Ecological Risk Assessment for the Richardson Flat Tailings

Station Information	Parameter	Sediment EPC (mg/kg)	Sediment Benchmark (mg/kg) Low	Sediment Benchmark (mg/kg) High	Sediment HQ Low	Sediment HQ High
	Aluminum	15,220	13,500	73,160	1E+00	2E-01
	Antimony	175	2	25	**9E+01**	**7E+00**
Silver Creek - upstream	Arsenic	393	9.79	33	**4E+01**	**1E+01**
	Cadmium	65.0	1.0	5.0	**7E+01**	**1E+01**
USC-5	Chromium	31.0	43.4	111	7E-01	3E-01
	Copper	1380	31.6	149	**4E+01**	**9E+00**
	Lead	11,190	36	128	**3E+02**	**9E+01**
Silver Creek above	Manganese	NA	631	4,460	NC	NC
Richardson Flats; at old	Mercury	0.5	0.18	1.06	**3E+00**	5E-01
north road to site	Nickel	NA	22.7	48.6	NC	NC
	Silver	48.0	0.73	3.7	**7E+01**	**1E+01**
	Zinc	12,270	121	459	**1E+02**	**3E+01**
	TOTAL HI				**7E+02**	**2E+02**
	Aluminum	4,930	13,500	73,160	4E-01	7E-02
	Antimony	889	2	25	**4E+02**	**4E+01**
Silver Creek - upstream	Arsenic	1735	9.79	33	**2E+02**	**5E+01**
	Cadmium	179.0	1.0	5.0	**2E+02**	**4E+01**
USC-6	Chromium	15.0	43.4	111	3E-01	1E-01
	Copper	2559	31.6	149	**8E+01**	**2E+01**
	Lead	42,990	36	128	**1E+03**	**3E+02**
	Manganese	NA	631	4,460	NC	NC
Silver Creek below Silver	Mercury	1.6	0.18	1.06	**9E+00**	**2E+00**
Maple Claims	Nickel	NA	22.7	48.6	NC	NC
	Silver	136.0	0.73	3.7	**2E+02**	**4E+01**
	Zinc	44,560	121	459	**4E+02**	**1E+02**
	TOTAL HI				**3E+03**	**6E+02**
	Aluminum	14,720	13,500	73,160	1E+00	2E-01
	Antimony	64	2	25	**3E+01**	**3E+00**
Silver Creek - upstream	Arsenic	105	9.79	33	**1E+01**	**3E+00**
	Cadmium	28.0	1.0	5.0	**3E+01**	**6E+00**
USC-7	Chromium	42.0	43.4	111	1E+00	4E-01
	Copper	652	31.6	149	**2E+01**	**4E+00**
	Lead	2,656	36	128	**7E+01**	**2E+01**
	Manganese	NA	631	4,460	NC	NC
Silver Creek above Silver	Mercury	0.8	0.18	1.06	**5E+00**	8E-01
Maple Claims	Nickel	NA	22.7	48.6	NC	NC
	Silver	51.0	0.73	3.7	**7E+01**	**1E+01**
	Zinc	4,619	121	459	**4E+01**	**1E+01**
	TOTAL HI				**3E+02**	**6E+01**
	Aluminum	11,250	13,500	73,160	8E-01	2E-01
	Antimony	140	2	25	**7E+01**	**6E+00**
Silver Creek - downstream	Arsenic	341	9.79	33	**3E+01**	**1E+01**
	Cadmium	50.0	1.0	5.0	**5E+01**	**1E+01**
USC-1	Chromium	30.0	43.4	111	7E-01	3E-01
	Copper	766	31.6	149	**2E+01**	**5E+00**
	Lead	11,130	36	128	**3E+02**	**9E+01**
Silver Creek below	Manganese	NA	631	4,460	NC	NC
Richardson Flat; at U248	Mercury	0.4	0.18	1.06	**2E+00**	4E-01
rail tressel	Nickel	NA	22.7	48.6	NC	NC
	Silver	49.0	0.73	3.7	**7E+01**	**1E+01**
	Zinc	11,730	121	459	**1E+02**	**3E+01**
	TOTAL HI				**7E+02**	**2E+02**
	Aluminum	11,590	13,500	73,160	9E-01	2E-01
	Antimony	137	2	25	**7E+01**	**5E+00**
Silver Creek - downstream	Arsenic	271	9.79	33	**3E+01**	**8E+00**
	Cadmium	58.0	1.0	5.0	**6E+01**	**1E+01**
USC-2	Chromium	32.0	43.4	111	7E-01	3E-01
	Copper	588	31.6	149	**2E+01**	**4E+00**
	Lead	6,942	36	128	**2E+02**	**5E+01**
Silver Creek below	Manganese	NA	631	4,460	NC	NC
Richardson Flat; at U248	Mercury	0.3	0.18	1.06	1E+00	2E-01
culvert	Nickel	NA	22.7	48.6	NC	NC
	Silver	40.0	0.73	3.7	**5E+01**	**1E+01**
	Zinc	11,950	121	459	**1E+02**	**3E+01**
	TOTAL HI				**5E+02**	**1E+02**

Table 7-4

Sediment Hazard Quotients (HQs) for Aquatic Receptors

Screening Ecological Risk Assessment for the Richardson Flat Tailings

Station Information	Parameter	Sediment EPC (mg/kg)	Sediment Benchmark (mg/kg)		Sediment HQ	
			Low	High	Low	High
South Diversion Ditch	Aluminum	4,850	13,500	73,160	4E-01	7E-02
RF-SD-SD1	Antimony	72	2	25	**4E+01**	**3E+00**
South Diversion Ditch	Arsenic	156	9.79	33	**2E+01**	**5E+00**
	Cadmium	73.0	1.0	5.0	**7E+01**	**1E+01**
	Chromium	18.0	43.4	111	4E-01	2E-01
	Copper	280	31.6	149	**9E+00**	**2E+00**
	Lead	3,490	36	128	**1E+02**	**3E+01**
	Manganese	NA	631	4,460	NC	NC
	Mercury	1.6	0.18	1.06	**9E+00**	**2E+00**
	Nickel	NA	22.7	48.6	NC	NC
	Silver	25.0	0.73	3.7	**3E+01**	**7E+00**
	Zinc	12,000	121	459	**1E+02**	**3E+01**
	TOTAL HI				**4E+02**	**9E+01**
South Diversion Ditch	Aluminum	6,450	13,500	73,160	5E-01	9E-02
RF-SD-SD2	Antimony	53	2	25	**3E+01**	**2E+00**
South Diversion Ditch	Arsenic	119	9.79	33	**1E+01**	**4E+00**
	Cadmium	50.0	1.0	5.0	**5E+01**	**1E+01**
	Chromium	16.0	43.4	111	4E-01	1E-01
	Copper	200	31.6	149	**6E+00**	1E+00
	Lead	2,330	36	128	**7E+01**	**2E+01**
	Manganese	NA	631	4,460	NC	NC
	Mercury	0.8	0.18	1.06	**4E+00**	7E-01
	Nickel	NA	22.7	48.6	NC	NC
	Silver	16.0	0.73	3.7	**2E+01**	**4E+00**
	Zinc	8,780	121	459	**7E+01**	**2E+01**
	TOTAL HI				**3E+02**	**6E+01**
South Diversion Ditch	Aluminum	10,500	13,500	73,160	8E-01	1E-01
RF-SD-SD3	Antimony	36	2	25	**2E+01**	1E+00
South Diversion Ditch	Arsenic	125	9.79	33	**1E+01**	**4E+00**
	Cadmium	35.0	1.0	5.0	**4E+01**	**7E+00**
	Chromium	21.0	43.4	111	5E-01	2E-01
	Copper	173	31.6	149	**5E+00**	1E+00
	Lead	1,880	36	128	**5E+01**	**1E+01**
	Manganese	NA	631	4,460	NC	NC
	Mercury	0.3	0.18	1.06	**2E+00**	3E-01
	Nickel	NA	22.7	48.6	NC	NC
	Silver	13.0	0.73	3.7	**2E+01**	**4E+00**
	Zinc	6,800	121	459	**6E+01**	**1E+01**
	TOTAL HI				**2E+02**	**5E+01**
South Diversion Ditch	Aluminum	7,480	13,500	73,160	6E-01	1E-01
RF-SD-SD4	Antimony	65	2	25	**3E+01**	**3E+00**
South Diversion Ditch	Arsenic	205	9.79	33	**2E+01**	**6E+00**
	Cadmium	51.0	1.0	5.0	**5E+01**	**1E+01**
	Chromium	18.0	43.4	111	4E-01	2E-01
	Copper	260	31.6	149	**8E+00**	**2E+00**
	Lead	2,840	36	128	**8E+01**	**2E+01**
	Manganese	NA	631	4,460	NC	NC
	Mercury	1.2	0.18	1.06	**7E+00**	1E+00
	Nickel	NA	22.7	48.6	NC	NC
	Silver	19.0	0.73	3.7	**3E+01**	**5E+00**
	Zinc	9,140	121	459	**8E+01**	**2E+01**
	TOTAL HI				**3E+02**	**7E+01**
South Diversion Ditch	Aluminum	8,650	13,500	73,160	6E-01	1E-01
RF-SD-SD5	Antimony	97	2	25	**5E+01**	**4E+00**
South Diversion Ditch	Arsenic	119	9.79	33	**1E+01**	**4E+00**
	Cadmium	38.0	1.0	5.0	**4E+01**	**8E+00**
	Chromium	18.0	43.4	111	4E-01	2E-01
	Copper	261	31.6	149	**8E+00**	**2E+00**
	Lead	2,660	36	128	**7E+01**	**2E+01**
	Manganese	NA	631	4,460	NC	NC
	Mercury	1.0	0.18	1.06	**6E+00**	9E-01
	Nickel	NA	22.7	48.6	NC	NC
	Silver	20.0	0.73	3.7	**3E+01**	**5E+00**
	Zinc	7,610	121	459	**6E+01**	**2E+01**
	TOTAL HI				**3E+02**	**6E+01**

Table 7-4

Sediment Hazard Quotients (HQs) for Aquatic Receptors

Screening Ecological Risk Assessment for the Richardson Flat Tailings

Station Information	Parameter	Sediment EPC (mg/kg)	Sediment Benchmark (mg/kg)		Sediment HQ	
			Low	High	Low	High
South Diversion Ditch	Aluminum	20,600	13,500	73,160	**2E+00**	3E-01
	Antimony	63	2	25	**3E+01**	**3E+00**
RF-SD-SD6	Arsenic	101	9.79	33	**1E+01**	**3E+00**
	Cadmium	18.0	1.0	5.0	**2E+01**	**4E+00**
South Diversion Ditch	Chromium	30.0	43.4	111	7E-01	3E-01
	Copper	211	31.6	149	**7E+00**	1E+00
	Lead	2,280	36	128	**6E+01**	**2E+01**
	Manganese	NA	631	4,460	NC	NC
	Mercury	1.5	0.18	1.06	**8E+00**	1E+00
	Nickel	NA	22.7	48.6	NC	NC
	Silver	14.0	0.73	3.7	**2E+01**	**4E+00**
	Zinc	2,940	121	459	**2E+01**	**6E+00**
	TOTAL HI				**2E+02**	**4E+01**
South Diversion Ditch - Wetland Area	Aluminum	28,800	13,500	73,160	**2E+00**	4E-01
	Antimony	99	2	25	**5E+01**	**4E+00**
RF-SE-01	Arsenic	202	9.79	33	**2E+01**	**6E+00**
	Cadmium	93.1	1.0	5.0	**9E+01**	**2E+01**
Diversion ditch wetlands area	Chromium	62.4	43.4	111	1E+00	6E-01
	Copper	725	31.6	149	**2E+01**	**5E+00**
	Lead	6,520	36	128	**2E+02**	**5E+01**
	Manganese	5060.0	631	4,460	**8E+00**	1E+00
	Mercury	8.2	0.18	1.06	**5E+01**	**8E+00**
	Nickel	51.2	22.7	48.6	**2E+00**	1E+00
	Silver	41.3	0.73	3.7	**6E+01**	**1E+01**
	Zinc	15,200	121	459	**1E+02**	**3E+01**
	TOTAL HI				**6E+02**	**1E+02**
South Diversion Ditch - Wetland Area	Aluminum	1,930	13,500	73,160	1E-01	3E-02
	Antimony	85	2	25	**4E+01**	**3E+00**
RF-SE-02	Arsenic	189	9.79	33	**2E+01**	**6E+00**
	Cadmium	52.8	1.0	5.0	**5E+01**	**1E+01**
Diversion ditch wetlands area	Chromium	15.8	43.4	111	4E-01	1E-01
	Copper	183	31.6	149	**6E+00**	1E+00
	Lead	3,010	36	128	**8E+01**	**2E+01**
	Manganese	2200.0	631	4,460	**3E+00**	5E-01
	Mercury	2.7	0.18	1.06	**2E+01**	**3E+00**
	Nickel	13.2	22.7	48.6	6E-01	3E-01
	Silver	10.7	0.73	3.7	**1E+01**	**3E+00**
	Zinc	8,160	121	459	**7E+01**	**2E+01**
	TOTAL HI				**3E+02**	**7E+01**
South Diversion Ditch - Wetland Area	Aluminum	4,530	13,500	73,160	3E-01	6E-02
	Antimony	99	2	25	**5E+01**	**4E+00**
RF-SE-03	Arsenic	310	9.79	33	**3E+01**	**9E+00**
	Cadmium	64.9	1.0	5.0	**7E+01**	**1E+01**
Diversion ditch wetlands area	Chromium	14.9	43.4	111	3E-01	1E-01
	Copper	313	31.6	149	**1E+01**	**2E+00**
	Lead	5,220	36	128	**1E+02**	**4E+01**
	Manganese	2330.0	631	4,460	**4E+00**	5E-01
	Mercury	2.4	0.18	1.06	**1E+01**	**2E+00**
	Nickel	21.3	22.7	48.6	9E-01	4E-01
	Silver	16.3	0.73	3.7	**2E+01**	**4E+00**
	Zinc	11,200	121	459	**9E+01**	**2E+01**
	TOTAL HI				**4E+02**	**1E+02**
South Diversion Ditch - Wetland Area	Aluminum	11,800	13,500	73,160	9E-01	2E-01
	Antimony	40	2	25	**2E+01**	**2E+00**
RF-SE-04	Arsenic	189	9.79	33	**2E+01**	**6E+00**
	Cadmium	40.3	1.0	5.0	**4E+01**	**8E+00**
Diversion ditch wetlands area	Chromium	25.0	43.4	111	6E-01	2E-01
	Copper	190	31.6	149	**6E+00**	1E+00
	Lead	2,350	36	128	**7E+01**	**2E+01**
	Manganese	42000.0	631	4,460	**7E+01**	**9E+00**
	Mercury	1.3	0.18	1.06	**7E+00**	1E+00
	Nickel	97.2	22.7	48.6	**4E+00**	**2E+00**
	Silver	8.0	0.73	3.7	**1E+01**	**2E+00**
	Zinc	5,400	121	459	**4E+01**	**1E+01**
	TOTAL HI				**3E+02**	**6E+01**

NA = Not Available
NC = Not Calculated

HQs in exceedance of the benchmark are shown in boldface type.

Table 7-5

Caclulation of Mean PEC Quotient and the Predicted Incidence of Sediment Toxicity

Screening Ecological Risk Assessment for Richardson Flat Tailings

Station Information	COPC	Sediment EPC (mg/kg)	Sediment Benchmark (mg/kg)	PEC Quotient	Mean PEC Quotient	Predicted Incidence of Observed Sediment Toxicity
Silver Creek - upstream USC-5 *Silver Creek above Richardson Flats; at old north road to site*	Arsenic	393	33	11.9	21.3	100.0%
	Cadmium	65	5.0	13.1		
	Chromium	31	111	0.3		
	Copper	1380	149	9.3		
	Lead	11,190	128	87.4		
	Mercury	0.5	1.06	0.5		
	Zinc	12,270	459	26.7		
Silver Creek - upstream USC-6 *Silver Creek below Silver Maple Claims*	Arsenic	1735	33	52.6	77.2	100.0%
	Cadmium	179.0	5.0	35.9		
	Chromium	15.0	111	0.1		
	Copper	2559	149	17.2		
	Lead	42,990	128	336		
	Mercury	1.6	1.06	1.5		
	Zinc	44,560	459	97.1		
Silver Creek - upstream USC-7 *Silver Creek above Silver Maple Claims*	Arsenic	105	33	3.2	6.5	100.0%
	Cadmium	28.0	5.0	5.6		
	Chromium	42.0	111	0.4		
	Copper	652	149	4.4		
	Lead	2,656	128	20.8		
	Mercury	0.8	1.06	0.8		
	Zinc	4,619	459	10.1		
Silver Creek - downstream USC-1 *Silver Creek below Richardson Flat; at U248 rail tressel*	Arsenic	341	33	10.3	19.8	100.0%
	Cadmium	50.0	5.0	10.0		
	Chromium	30.0	111	0.3		
	Copper	766	149	5.1		
	Lead	11,130	128	87.0		
	Mercury	0.4	1.06	0.4		
	Zinc	11,730	459	25.6		
Silver Creek - downstream USC-2 *Silver Creek below Richardson Flat; at U248 culvert*	Arsenic	271	33	8.2	14.9	100.0%
	Cadmium	58.0	5.0	11.6		
	Chromium	32.0	111	0.3		
	Copper	588	149	3.9		
	Lead	6,942	128	54.2		
	Mercury	0.3	1.06	0.2		
	Zinc	11,950	459	26.0		
South Diversion Ditch RF-SD-SD1 *South Diversion Ditch*	Arsenic	156	33	4.7	10.9	100.0%
	Cadmium	73.0	5.0	14.7		
	Chromium	18.0	111	0.2		
	Copper	280	149	1.9		
	Lead	3,490	128	27.3		
	Mercury	1.6	1.06	1.5		
	Zinc	12,000	459	26.1		
South Diversion Ditch RF-SD-SD2 *South Diversion Ditch*	Arsenic	119	33	3.6	7.6	100.0%
	Cadmium	50.0	5.0	10.0		
	Chromium	16.0	111	0.1		
	Copper	200	149	1.3		
	Lead	2,330	128	18.2		
	Mercury	0.8	1.06	0.7		
	Zinc	8,780	459	19.1		
South Diversion Ditch RF-SD-SD3 *South Diversion Ditch*	Arsenic	125	33	3.8	6.0	100.0%
	Cadmium	35.0	5.0	7.0		
	Chromium	21.0	111	0.2		
	Copper	173	149	1.2		
	Lead	1,880	128	14.7		
	Mercury	0.3	1.06	0.3		
	Zinc	6,800	459	14.8		
South Diversion Ditch RF-SD-SD4 *South Diversion Ditch*	Arsenic	205	33	6.2	8.8	100.0%
	Cadmium	51.0	5.0	10.2		
	Chromium	18.0	111	0.2		
	Copper	260	149	1.7		
	Lead	2,840	128	22.2		
	Mercury	1.2	1.06	1.1		
	Zinc	9,140	459	19.9		

Table 7-5

Caclulation of Mean PEC Quotient and the Predicted Incidence of Sediment Toxicity

Screening Ecological Risk Assessment for Richardson Flat Tailings

Station Information	COPC	Sediment EPC (mg/kg)	Sediment Benchmark (mg/kg)	PEC Quotient	Mean PEC Quotient	Predicted Incidence of Observed Sediment Toxicity
South Diversion Ditch	Arsenic	119	33	3.6	7.4	100.0%
RF-SD-SD5	Cadmium	38.0	5.0	7.6		
South Diversion Ditch	Chromium	18.0	111	0.2		
	Copper	261	149	1.8		
	Lead	2,660	128	20.8		
	Mercury	1.0	1.06	0.9		
	Zinc	7,610	459	16.6		
South Diversion Ditch	Arsenic	101	33	3.1	4.9	100.0%
RF-SD-SD6	Cadmium	18.0	5.0	3.6		
South Diversion Ditch	Chromium	30.0	111	0.3		
	Copper	211	149	1.4		
	Lead	2,280	128	17.8		
	Mercury	1.5	1.06	1.4		
	Zinc	2,940	459	6.4		
South Diversion Ditch - Wetland Area	Arsenic	202	33	6.1	17.4	100.0%
RF-SE-01	Cadmium	93.1	5.0	18.7		
Diversion ditch wetlands area	Chromium	62.4	111	0.6		
	Copper	725	149	4.9		
	Lead	6,520	128	50.9		
	Mercury	8.2	1.06	7.7		
	Zinc	15,200	459	33.1		
South Diversion Ditch - Wetland Area	Arsenic	189	33	5.7	8.8	100.0%
RF-SE-02	Cadmium	52.8	5.0	10.6		
Diversion ditch wetlands area	Chromium	15.8	111	0.1		
	Copper	183	149	1.2		
	Lead	3,010	128	23.5		
	Mercury	2.7	1.06	2.5		
	Zinc	8,160	459	17.8		
South Diversion Ditch - Wetland Area	Arsenic	310	33	9.4	13.2	100.0%
RF-SE-03	Cadmium	64.9	5.0	13.0		
Diversion ditch wetlands area	Chromium	14.9	111	0.1		
	Copper	313	149	2.1		
	Lead	5,220	128	40.8		
	Mercury	2.4	1.06	2.3		
	Zinc	11,200	459	24.4		
South Diversion Ditch - Wetland Area	Arsenic	189	33	5.7	6.7	100.0%
RF-SE-04	Cadmium	40.3	5.0	8.1		
Diversion ditch wetlands area	Chromium	25.0	111	0.2		
	Copper	190	149	1.3		
	Lead	2,350	128	18.4		
	Mercury	1.3	1.06	1.2		
	Zinc	5,400	459	11.8		

NA = Not Available
NC = Not Calculated

HQs in exceedance of the benchmark are shown in boldface type.

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Table 7-6
Seep* Hazard Quotients (HQs) for Aquatic Receptors

Screening Ecological Risk Assessment for Richardson Flat Tailings

Station Information	Parameter	Groundwater EPC (ug/L)		Total Ambient Water Quality Criteria (ug/L)		Dissolved Ambient Water Quality Criteria (ug/L)		Total HQ		Dissolved HQ	
		Total	Dissolved	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic
	Aluminum	80,700	50	750	87	750	87	**1E+02**	**9E+02**	7E-02	6E-01
Site Monitoring Well	Arsenic	76	3.6	340	150	340	150	2E-01	5E-01	1E-02	2E-02
	Cadmium	42	3.3	4	0	4	0	**1E+01**	**9E+01**	8E-01	**8E+00**
MW-01	**Chromium**	**95**	**7.8**	**16**	**11**	**5.1**	**9.5**	**6E+00**	**9E+00**	**2E+00**	**8E-01**
	Copper	1,583	20	27	17	26	16	**6E+01**	**9E+01**	8E-01	1E+00
Monitoring well #1 below	Cyanide	32	NA	22	5.2	22	5.2	1E+00	**6E+00**	NC	NC
main embankment	Lead	88	92	197	5	136	4	4E-01	**2E+01**	7E-01	**2E+01**
	Mercury	0.3	0.2	1.4	0.8	1.2	0.7	2E-01	4E-01	2E-01	3E-01
Hardness 200 (mg/L)	**Selenium**	**15**	**15**	**19**	**5.0**	**18**	**4.6**	**8E-01**	**3E+00**	**8E-01**	**3E+00**
	Silver	2	10	13	NA	11	NA	2E-01	NC	9E-01	NC
	Zinc	**650**	**108**	**216**	**216**	**211**	**213**	**3E+00**	**3E+00**	**5E-01**	**5E-01**
	TOTAL HI							**2E+02**	**1E+03**	**6E+00**	**4E+01**
	Aluminum	NA	NA	750	87	750	87	NC	NC	NC	NC
Site Monitoring Well	Arsenic	NA	NA	340	150	340	150	NC	NC	NC	NC
	Cadmium	NA	NA	4	0	4	0	NC	NC	NC	NC
MW-03	**Chromium**	**NA**	**NA**	**16**	**11**	**5.1**	**9.5**	**NC**	**NC**	**NC**	**NC**
	Copper	10	NA	27	17	26	16	4E-01	6E-01	NC	NC
Monitoring well #3 below	Cyanide	8	NA	22	5.2	22	5.2	4E-01	**2E+00**	NC	NC
main embankment	Lead	69	49	197	5	136	4	4E-01	**1E+01**	4E-01	**1E+01**
	Mercury	2.1	NA	1.4	0.8	1.2	0.7	**2E+00**	**3E+00**	NC	NC
Hardness 200 (mg/L)	**Selenium**	**NA**	**NA**	**19**	**5.0**	**18**	**4.6**	**NC**	**NC**	**NC**	**NC**
	Silver	NA	NA	13	NA	11	NA	NC	NC	NC	NC
	Zinc	**NA**	**70**	**216**	**216**	**211**	**213**	**NC**	**NC**	**3E-01**	**3E-01**
	TOTAL HI							**3E+00**	**2E+01**	**7E-01**	**1E+01**
	Aluminum	NA	NA	750	87	750	87	NC	NC	NC	NC
Site Monitoring Well	Arsenic	NA	NA	340	150	340	150	NC	NC	NC	NC
	Cadmium	NA	NA	4	0	4	0	NC	NC	NC	NC
MW-04	**Chromium**	**NA**	**NA**	**16**	**11**	**5.1**	**9.5**	**NC**	**NC**	**NC**	**NC**
	Copper	15	NA	27	17	26	16	6E-01	9E-01	NC	NC
Monitoring well #4 below	Cyanide	11,816	NA	22	5.2	22	5.2	**5E+02**	**2E+03**	NC	NC
main embankment	Lead	120	58	197	5	136	4	6E-01	**2E+01**	4E-01	**1E+01**
	Mercury	0.7	NA	1.4	0.8	1.2	0.7	5E-01	9E-01	NC	NC
Hardness 200 (mg/L)	**Selenium**	**NA**	**NA**	**19**	**5.0**	**18**	**4.6**	**NC**	**NC**	**NC**	**NC**
	Silver	NA	NA	13	NA	11	NA	NC	NC	NC	NC
	Zinc	**NA**	**200**	**216**	**216**	**211**	**213**	**NC**	**NC**	**9E-01**	**9E-01**
	TOTAL HI							**5E+02**	**2E+03**	**1E+00**	**2E+01**
	Aluminum	NA	NA	750	87	750	87	NC	NC	NC	NC
Site Monitoring Well	Arsenic	NA	NA	340	150	340	150	NC	NC	NC	NC
	Cadmium	NA	NA	4	0	4	0	NC	NC	NC	NC
MW-05	**Chromium**	**NA**	**NA**	**16**	**11**	**5.1**	**9.5**	**NC**	**NC**	**NC**	**NC**
	Copper	15	NA	27	17	26	16	6E-01	9E-01	NC	NC
Monitoring well #5 below	Cyanide	37	NA	22	5.2	22	5.2	**2E+00**	**7E+00**	NC	NC
main embankment	Lead	131	61	197	5	136	4	7E-01	**2E+01**	4E-01	**2E+01**
	Mercury	2.2	NA	1.4	0.8	1.2	0.7	**2E+00**	**3E+00**	NC	NC
Hardness 200 (mg/L)	**Selenium**	**NA**	**NA**	**19**	**5.0**	**18**	**4.6**	**NC**	**NC**	**NC**	**NC**
	Silver	NA	NA	13	NA	11	NA	NC	NC	NC	NC
	Zinc	**NA**	**1,900**	**216**	**216**	**211**	**213**	**NC**	**NC**	**9E+00**	**9E+00**
	TOTAL HI							**4E+00**	**4E+01**	**9E+00**	**2E+01**
	Aluminum	4,920	69	750	87	750	87	**7E+00**	**6E+01**	9E-02	8E-01
Site Monitoring Well	Arsenic	349	9.0	340	150	340	150	1E+00	**2E+00**	3E-02	6E-02
	Cadmium	16	3.3	4	0	4	0	**4E+00**	**4E+01**	8E-01	**8E+00**
MW-06	**Chromium**	**42**	**7.8**	**16**	**11**	**5.1**	**9.5**	**3E+00**	**4E+00**	**2E+00**	**8E-01**
	Copper	190	20	27	17	26	16	**7E+00**	**1E+01**	8E-01	1E+00
Monitoring well #6 below	Cyanide	1,552	NA	22	5.2	22	5.2	**7E+01**	**3E+02**	NC	NC
main embankment	Lead	142	37	197	5	136	4	7E-01	**3E+01**	3E-01	**9E+00**
	Mercury	0.5	0.2	1.4	0.8	1.2	0.7	4E-01	6E-01	2E-01	3E-01
Hardness 200 (mg/L)	**Selenium**	**15**	**15**	**19**	**5.0**	**18**	**4.6**	**8E-01**	**3E+00**	**8E-01**	**3E+00**
	Silver	17	10	13	NA	11	NA	1E+00	NC	9E-01	NC
	Zinc	**2,790**	**73**	**216**	**216**	**211**	**213**	**1E+01**	**1E+01**	**3E-01**	**3E-01**
	TOTAL HI							**1E+02**	**5E+02**	**6E+00**	**2E+01**
	Aluminum	15,700	191	750	87	750	87	**2E+01**	**2E+02**	3E-01	**2E+00**
Background	Arsenic	4	3.6	340	150	340	150	1E-02	2E-02	1E-02	2E-02
	Cadmium	3	3.3	4	0	4	0	8E-01	**7E+00**	8E-01	**8E+00**
RT-1	**Chromium**	**11**	**7.8**	**16**	**11**	**5.1**	**9.5**	**7E-01**	**1E+00**	**2E+00**	**8E-01**
	Copper	30	171	27	17	26	16	1E+00	**2E+00**	**7E+00**	**1E+01**
	Cyanide	5	NA	22	5.2	22	5.2	2E-01	1E+00	NC	NC
Upstream monitoring well	Lead	627	41	197	5	136	4	**3E+00**	**1E+02**	3E-01	**1E+01**
	Mercury	0.2	0.2	1.4	0.8	1.2	0.7	1E-01	3E-01	2E-01	3E-01
Hardness 200 (mg/L)	**Selenium**	**3**	**3**	**19**	**5.0**	**18**	**4.6**	**2E-01**	**6E-01**	**2E-01**	**7E-01**
	Silver	2	10	13	NA	11	NA	2E-01	NC	9E-01	NC
	Zinc	**136**	**20**	**216**	**216**	**211**	**213**	**6E-01**	**6E-01**	**1E-01**	**9E-02**
	TOTAL HI							**3E+01**	**3E+02**	**1E+01**	**3E+01**

NA = Not Available
NC = Not Calculated

Concentrations are calculated using 1/2 the detection limit for non-detects "U".
If well-specific hardness is not available, a well hardness of 200 mg/L is assumed.
If hardness is greater than AWQC upper hardness limit, the upper hardness limit is used to calulate the AWQC.
HQs in exceedance of the benchmark are shown in boldface type.

***Seep concentrations are estimated using available groundwater data.**

Table 7-7
Surface Water Hazard Quotients (HQs) for Amphibians

Screening Ecological Risk Assessment for Richardson Flat Tailings

Station Information	Parameter	Surface Water Exposure Concentration Max (ug/L)		Amphibian Screening Benchmark (ug/L)	Amphibian HQ
		Total	Dissolved		
Silver Creek - upstream *492685* *SILVER CK AT US40 XING E OF PARK CITY*	Arsenic	NA	3.27	4.0	8E-01
	Cadmium	NA	3.27	4.0	8E-01
	Copper	NA	7.79	4.0	**2E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	NA	6.3	4.0	**2E+00**
	Mercury	NA	0.10	0.1	1E+00
	Selenium	NA	1.84	9.0	2E-01
	Silver	NA	1.00	9.0	1E-01
	Zinc	NA	1170	1.0	**1E+03**
	TOTAL HI				**1E+03**
Silver Creek - upstream *492695* *SILVER CK @ CITY PARK AB PROSPECTOR SQUARE*	Arsenic	NA	2.50	4.0	6E-01
	Cadmium	NA	12.00	4.0	**3E+00**
	Copper	NA	8.57	4.0	**2E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	NA	5.0	4.0	1E+00
	Mercury	NA	0.10	0.1	1E+00
	Selenium	NA	1.97	9.0	2E-01
	Silver	NA	1.00	9.0	1E-01
	Zinc	NA	1011	1.0	**1E+03**
	TOTAL HI				**1E+03**
Silver Creek - upstream *N4* *Silver Creek upstream of diversion ditch*	Arsenic	NA	NA	4.0	NC
	Cadmium	NA	NA	4.0	NC
	Copper	390.00	NA	4.0	**1E+02**
	Cyanide	6.44	NA	0.3	**2E+01**
	Lead	1480.5	20.0	4.0	**4E+02**
	Mercury	143.01	NA	0.1	**1E+03**
	Selenium	NA	NA	9.0	NC
	Silver	NA	NA	9.0	NC
	Zinc	1350	560	1.0	**1E+03**
	TOTAL HI				**3E+03**
Silver Creek - upstream *RF-7* *Silver Creek upstream of confluence with south diversion ditch*	Arsenic	10.00	7.00	4.0	**3E+00**
	Cadmium	4.00	2.00	4.0	1E+00
	Copper	13.00	4.17	4.0	**3E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	74.0	2.5	4.0	**2E+01**
	Mercury	0.25	0.25	0.1	**3E+00**
	Selenium	2.50	2.50	9.0	3E-01
	Silver	4.38	4.38	9.0	5E-01
	Zinc	96000	83000	1.0	**1E+05**
	TOTAL HI				**1E+05**
Silver Creek - upstream *RF-7-2* *Silver Creek upstream of confluence with south diversion ditch*	Arsenic	13.00	8.18	4.0	**3E+00**
	Cadmium	8.00	6.00	4.0	**2E+00**
	Copper	7.73	6.46	4.0	**2E+00**
	Cyanide	2.00	NA	0.3	**8E+00**
	Lead	78.0	4.9	4.0	**2E+01**
	Mercury	0.24	0.22	0.1	**2E+00**
	Selenium	4.69	2.31	9.0	5E-01
	Silver	12.58	3.75	9.0	1E+00
	Zinc	2100	2000	1.0	**2E+03**
	TOTAL HI				**2E+03**
Silver Creek - upstream *RF-SW-01* *Silver Creek upstream of diversion ditch*	Arsenic	4.20	NA	4.0	1E+00
	Cadmium	3.90	NA	4.0	1E+00
	Copper	10.00	NA	4.0	**3E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	35.3	NA	4.0	**9E+00**
	Mercury	0.10	NA	0.1	1E+00
	Selenium	7.50	NA	9.0	8E-01
	Silver	1.20	NA	9.0	1E-01
	Zinc	1110	NA	1.0	**1E+03**
	TOTAL HI				**1E+03**

Table 7-7
Surface Water Hazard Quotients (HQs) for Amphibians

Screening Ecological Risk Assessment for Richardson Flat Tailings

Station Information	Parameter	Surface Water Exposure Concentration Max (ug/L)		Amphibian Screening Benchmark (ug/L)	Amphibian HQ
		Total	Dissolved		
Silver Creek - upstream *RF-SW-02* *Silver Creek upstream of diversion ditch*	Arsenic	5.20	NA	4.0	1E+00
	Cadmium	1.65	NA	4.0	4E-01
	Copper	10.00	NA	4.0	**3E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	18.8	NA	4.0	**5E+00**
	Mercury	0.10	NA	0.1	1E+00
	Selenium	7.50	NA	9.0	8E-01
	Silver	1.20	NA	9.0	1E-01
	Zinc	2080.00	NA	1.0	**2E+03**
	TOTAL HI				**2E+03**
Silver Creek - upstream *RF-SW-03* *Silver Creek upstream of diversion ditch*	Arsenic	7.30	NA	4.0	**2E+00**
	Cadmium	1.65	NA	4.0	4E-01
	Copper	10.00	NA	4.0	**3E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	15.00	NA	4.0	**4E+00**
	Mercury	0.10	NA	0.1	1E+00
	Selenium	7.50	NA	9.0	8E-01
	Silver	1.20	NA	9.0	1E-01
	Zinc	769.00	NA	1.0	**8E+02**
	TOTAL HI				**8E+02**
Silver Creek - upstream *RF-SW-04* *Silver Creek upstream of diversion ditch*	Arsenic	7.60	NA	4.0	**2E+00**
	Cadmium	3.50	NA	4.0	9E-01
	Copper	10.00	NA	4.0	**3E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	36.40	NA	4.0	**9E+00**
	Mercury	0.10	NA	0.1	1E+00
	Selenium	7.50	NA	9.0	8E-01
	Silver	1.20	NA	9.0	1E-01
	Zinc	776.00	NA	1.0	**8E+02**
	TOTAL HI				**8E+02**
Silver Creek - upstream *USC-3* *Silver Creek at Richardson Flats; upstream of RR tressel*	Arsenic	7.00	7.00	4.0	**2E+00**
	Cadmium	3.00	1.00	4.0	8E-01
	Copper	7.00	2.50	4.0	**2E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	41.00	2.50	4.0	**1E+01**
	Mercury	NA	NA	0.1	NC
	Selenium	2.50	2.50	9.0	3E-01
	Silver	2.50	2.50	9.0	3E-01
	Zinc	1200.00	1100.00	1.0	**1E+03**
	TOTAL HI				**1E+03**
Silver Creek - upstream *USC-5* *Silver Creek above Richardson Flats; at old north road to site*	Arsenic	2.50	5.00	4.0	6E-01
	Cadmium	6.00	1.00	4.0	**2E+00**
	Copper	9.00	7.00	4.0	**2E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	26.00	2.50	4.0	**7E+00**
	Mercury	NA	NA	0.1	NC
	Selenium	2.50	2.50	9.0	3E-01
	Silver	2.50	2.50	9.0	3E-01
	Zinc	1900.00	2000.00	1.0	**2E+03**
	TOTAL HI				**2E+03**
Silver Creek - upstream *USC-6* *Silver Creek below Silver Maple Claims*	Arsenic	19.00	8.00	4.0	**5E+00**
	Cadmium	2.00	2.00	4.0	5E-01
	Copper	6.00	2.50	4.0	**2E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	31.00	2.50	4.0	**8E+00**
	Mercury	0.04	0.00	0.1	4E-01
	Selenium	2.50	2.50	9.0	3E-01
	Silver	2.50	2.50	9.0	3E-01
	Zinc	1400.00	1400.00	1.0	**1E+03**
	TOTAL HI				**1E+03**

Table 7-7
Surface Water Hazard Quotients (HQs) for Amphibians

Screening Ecological Risk Assessment for Richardson Flat Tailings

Station Information	Parameter	Surface Water Exposure Concentration Max (ug/L) Total	Dissolved	Amphibian Screening Benchmark (ug/L)	Amphibian HQ
Silver Creek - upstream *USC-7* *Silver Creek above Silver Maple Claims*	Arsenic	2.50	5.00	4.0	6E-01
	Cadmium	10.00	7.00	4.0	**3E+00**
	Copper	18.00	12.00	4.0	**5E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	27.00	2.25	4.0	**7E+00**
	Mercury	0.05	0.00	0.1	5E-01
	Selenium	2.50	2.50	9.0	3E-01
	Silver	2.13	2.13	9.0	2E-01
	Zinc	2500.00	2100.00	1.0	**3E+03**
	TOTAL HI				**3E+03**
Silver Creek - downstream *492679* *SILVER CREEK WWTP*	Arsenic	8.70	12.00	4.0	**2E+00**
	Cadmium	0.50	0.50	4.0	1E-01
	Copper	6.00	6.00	4.0	**2E+00**
	Cyanide	5.00	NA	0.3	**2E+01**
	Lead	1.50	1.50	4.0	4E-01
	Mercury	0.10	0.10	0.1	1E+00
	Selenium	0.50	1.20	9.0	6E-02
	Silver	1.00	1.00	9.0	1E-01
	Zinc	170.00	330.00	1.0	**2E+02**
	TOTAL HI				**2E+02**
Silver Creek - downstream *492680* *SILVER CK AB ATKINSON*	Arsenic	NA	7.60	4.0	**2E+00**
	Cadmium	NA	1.08	4.0	3E-01
	Copper	NA	6.00	4.0	**2E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	NA	9.81	4.0	**2E+00**
	Mercury	NA	0.10	0.1	1E+00
	Selenium	NA	1.20	9.0	1E-01
	Silver	NA	1.00	9.0	1E-01
	Zinc	NA	765.00	1.0	**8E+02**
	TOTAL HI				**8E+02**
Silver Creek - downstream *N6* *Silver Creek downstream of diversion ditch*	Arsenic	NA	NA	4.0	NC
	Cadmium	NA	NA	4.0	NC
	Copper	10.24	NA	4.0	**3E+00**
	Cyanide	2.65	NA	0.3	**1E+01**
	Lead	145.34	25.00	4.0	**4E+01**
	Mercury	133.06	NA	0.1	**1E+03**
	Selenium	NA	NA	9.0	NC
	Silver	NA	NA	9.0	NC
	Zinc	901.51	370.00	1.0	**9E+02**
	TOTAL HI				**2E+03**
Silver Creek - downstream *RF-8* *Silver Creek downstream of confluence with south diversion ditch*	Arsenic	31.00	8.24	4.0	**8E+00**
	Cadmium	9.00	2.06	4.0	**2E+00**
	Copper	10.43	4.12	4.0	**3E+00**
	Cyanide	2.00	NA	0.3	**8E+00**
	Lead	340.00	5.62	4.0	**9E+01**
	Mercury	0.35	0.22	0.1	**3E+00**
	Selenium	5.00	2.36	9.0	6E-01
	Silver	4.95	3.95	9.0	5E-01
	Zinc	1700.00	1100.00	1.0	**2E+03**
	TOTAL HI				**2E+03**
Silver Creek - downstream *RF-8-2* *Silver Creek downstream of confluence with south diversion ditch*	Arsenic	10.00	10.00	4.0	**3E+00**
	Cadmium	3.00	2.00	4.0	8E-01
	Copper	5.00	5.00	4.0	1E+00
	Cyanide	NA	NA	0.3	NC
	Lead	28.00	2.50	4.0	**7E+00**
	Mercury	0.25	0.25	0.1	**3E+00**
	Selenium	2.50	2.50	9.0	3E-01
	Silver	5.00	5.00	9.0	6E-01
	Zinc	850.00	850.00	1.0	**9E+02**
	TOTAL HI				**9E+02**

Table 7-7
Surface Water Hazard Quotients (HQs) for Amphibians

DRAFT

Screening Ecological Risk Assessment for Richardson Flat Tailings

Station Information	Parameter	Surface Water Exposure Concentration Max (ug/L)		Amphibian Screening Benchmark (ug/L)	Amphibian HQ
		Total	Dissolved		
Silver Creek - downstream *RF-SW-05* *Silver Creek downstream of diversion ditch*	Arsenic	7.20	NA	4.0	**2E+00**
	Cadmium	1.65	NA	4.0	4E-01
	Copper	10.00	NA	4.0	**3E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	151.00	NA	4.0	**4E+01**
	Mercury	0.10	NA	0.1	1E+00
	Selenium	7.50	NA	9.0	8E-01
	Silver	1.20	NA	9.0	1E-01
	Zinc	466.00	NA	1.0	**5E+02**
	TOTAL HI				**5E+02**
Silver Creek - downstream *RF-SW-06* *Silver Creek downstream of diversion ditch*	Arsenic	12.50	NA	4.0	**3E+00**
	Cadmium	1.65	NA	4.0	4E-01
	Copper	10.00	NA	4.0	**3E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	33.20	NA	4.0	**8E+00**
	Mercury	0.10	NA	0.1	1E+00
	Selenium	7.50	NA	9.0	8E-01
	Silver	NA	NA	9.0	NC
	Zinc	321.00	NA	1.0	**3E+02**
	TOTAL HI				**3E+02**
Silver Creek - downstream *USC-1* *Silver Creek below Richardson Flat; at U248 rail tressel*	Arsenic	6.00	6.00	4.0	**2E+00**
	Cadmium	2.00	1.83	4.0	5E-01
	Copper	12.00	2.50	4.0	**3E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	51.00	2.50	4.0	**1E+01**
	Mercury	0.11	0.00	0.1	1E+00
	Selenium	2.50	2.50	9.0	3E-01
	Silver	2.50	2.50	9.0	3E-01
	Zinc	1100.00	1000.00	1.0	**1E+03**
	TOTAL HI				**1E+03**
Silver Creek - downstream *USC-2* *Silver Creek below Richardson Flat; at U248 culvert*	Arsenic	2.50	7.00	4.0	6E-01
	Cadmium	2.00	1.50	4.0	5E-01
	Copper	2.50	2.50	4.0	6E-01
	Cyanide	NA	NA	0.3	NC
	Lead	16.00	12.00	4.0	**4E+00**
	Mercury	NA	NA	0.1	NC
	Selenium	2.50	2.50	9.0	3E-01
	Silver	7.00	2.50	9.0	8E-01
	Zinc	630.00	710.00	1.0	**6E+02**
	TOTAL HI				**6E+02**
South Diversion Ditch *N5* *Diversion Ditch*	Arsenic	NA	NA	4.0	NC
	Cadmium	NA	NA	4.0	NC
	Copper	10.87	NA	4.0	**3E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	44.61	NA	4.0	**1E+01**
	Mercury	0.20	NA	0.1	**2E+00**
	Selenium	NA	NA	9.0	NC
	Silver	NA	NA	9.0	NC
	Zinc	918.35	NA	1.0	**9E+02**
	TOTAL HI				**9E+02**
South Diversion Ditch *RF-2* *South diversion ditch*	Arsenic	5.00	6.00	4.0	1E+00
	Cadmium	0.50	0.50	4.0	1E-01
	Copper	18.00	16.00	4.0	**5E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	5.00	5.00	4.0	1E+00
	Mercury	0.28	0.20	0.1	**3E+00**
	Selenium	2.25	2.25	9.0	3E-01
	Silver	3.75	3.75	9.0	4E-01
	Zinc	94.00	79.00	1.0	**9E+01**
	TOTAL HI				**1E+02**

Table 7-7
Surface Water Hazard Quotients (HQs) for Amphibians

DRAFT

Screening Ecological Risk Assessment for Richardson Flat Tailings

Station Information	Parameter	Surface Water Exposure Concentration Max (ug/L)		Amphibian Screening Benchmark (ug/L)	Amphibian HQ
		Total	Dissolved		
South Diversion Ditch *RF-4* *South diversion ditch*	Arsenic	8.00	8.00	4.0	**2E+00**
	Cadmium	2.00	0.50	4.0	5E-01
	Copper	17.00	11.23	4.0	**4E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	2.50	3.61	4.0	6E-01
	Mercury	0.35	0.20	0.1	**3E+00**
	Selenium	2.17	2.17	9.0	2E-01
	Silver	3.33	3.33	9.0	4E-01
	Zinc	2700.00	2600.00	1.0	**3E+03**
	TOTAL HI				**3E+03**
South Diversion Ditch *RF-5* *South diversion ditch*	Arsenic	6.00	5.00	4.0	**2E+00**
	Cadmium	1.00	0.50	4.0	3E-01
	Copper	12.13	9.11	4.0	**3E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	9.00	2.50	4.0	**2E+00**
	Mercury	0.26	0.22	0.1	**3E+00**
	Selenium	0.00	2.20	9.0	4E-04
	Silver	9.86	3.64	9.0	1E+00
	Zinc	900.00	860.00	1.0	**9E+02**
	TOTAL HI				**9E+02**
South Diversion Ditch *RF-5-4* *South diversion ditch*	Arsenic	8.00	7.00	4.0	**2E+00**
	Cadmium	2.00	0.50	4.0	5E-01
	Copper	18.00	17.00	4.0	**5E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	2.50	2.50	4.0	6E-01
	Mercury	0.24	0.22	0.1	**2E+00**
	Selenium	2.00	2.00	9.0	2E-01
	Silver	2.50	2.50	9.0	3E-01
	Zinc	2600.00	2500.00	1.0	**3E+03**
	TOTAL HI				**3E+03**
South Diversion Ditch *RF-6* *South diversion ditch*	Arsenic	6.00	6.00	4.0	**2E+00**
	Cadmium	2.02	1.69	4.0	5E-01
	Copper	5.00	5.00	4.0	1E+00
	Cyanide	2.00	NA	0.3	**8E+00**
	Lead	48.00	2.50	4.0	**1E+01**
	Mercury	0.23	0.25	0.1	**2E+00**
	Selenium	3.73	2.61	9.0	4E-01
	Silver	4.50	4.44	9.0	5E-01
	Zinc	850.00	850.00	1.0	**9E+02**
	TOTAL HI				**9E+02**
South Diversion Ditch *RF-6-2* *South diversion ditch*	Arsenic	750.00	3.86	4.0	**2E+02**
	Cadmium	0.00	0.64	4.0	5E-04
	Copper	9.97	6.88	4.0	**2E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	16.00	3.65	4.0	**4E+00**
	Mercury	0.32	0.00	0.1	**3E+00**
	Selenium	5.87	2.09	9.0	7E-01
	Silver	4.80	3.41	9.0	5E-01
	Zinc	310.00	150.00	1.0	**3E+02**
	TOTAL HI				**5E+02**
South Diversion Ditch *USC-4* *Richardson Flats diversion ditch 50'*	Arsenic	6.00	2.50	4.0	**2E+00**
	Cadmium	1.83	1.83	4.0	5E-01
	Copper	6.00	2.50	4.0	**2E+00**
	Cyanide	NA	NA	0.3	NC
	Lead	11.00	2.50	4.0	**3E+00**
	Mercury	0.00	0.00	0.1	2E-02
	Selenium	2.50	2.50	9.0	3E-01
	Silver	2.50	2.50	9.0	3E-01
	Zinc	110.00	100.00	1.0	**1E+02**
	TOTAL HI				**1E+02**
Site Ponded Water *RF-9*	Arsenic	10.00	10.00	4.0	**3E+00**
	Cadmium	0.50	0.50	4.0	1E-01
	Copper	5.00	5.00	4.0	1E+00

Table 7-8 Summary of Species Toxicity Values for Amphibians

Screening Ecological Risk Assessment for Richardson Flat Tailings

Species	Endpoint Type	Exposure Duration	Arsenic	Copper	Lead	Mercury*	Zinc
Leopard frog (*Rana pipiens*)	Death	30 days	na	na	100	na	na
Leopard frog (*Rana pipiens*)	EC50 (death & deformity)	8 days	na	50	na	7	na
Narrow-mouthed toad (*Gastrophryne carolinensis*)	EC50 (death & deformity)	7 days	40	21	17	1	6
Marbled salamander (*Ambystoma spacum*)	EC50 (death & deformity)	8 days	4450	777	1,479	108	2,400
African clawed toad (*Xenopus laevis*)	LC50	48 hrs	na	na	na	74	34,500
American toad (*Bufo americanus*)	Avoidance threshold	80 min	na	100	na	na	na
Fowler's toad (*Bufo fowleri*)	EC50 (death & deformity)	7 min	na	26,960	na	66	na
Southern gray tree frog (*Hyla chrysoscelis*)	EC50 (death & deformity)	7 min	na	40	na	2	na

All concentrations are total recoverable and units are in ug/L.
All values are based on data given in EPA 1985 b-e, 1987, 1996.
* For mercury, additional toxicity endpoints are presented in Figure 7-8d.

All hardness dependant values are adjusted to a hardness of 100 mg/L.
na = Not Available

Table 7-9
Seep* Hazard Quotients (HQs) for Amphibians

Screening Ecological Risk Assessment for Richardson Flat Tailings

Station Information	Parameter	Groundwater Exposure Concentration Max (ug/L) Total	Dissolved	Amphibian Screening Benchmark (ug/L)	Amphibian HQ
Site Monitoring Well	Arsenic	76	3.6	4.0	**2E+01**
	Cadmium	42	3.3	4.0	**1E+01**
MW-01	Copper	1,583	20	4.0	**4E+02**
	Cyanide	32	NA	0.3	**1E+02**
	Lead	88	92	4.0	**2E+01**
Monitoring well #1 below main embankment	Mercury	0.3	0.2	0.1	**3E+00**
	Selenium	15	15	9.0	**2E+00**
	Silver	2	10	9.0	3E-01
	Zinc	650	108	1.0	**7E+02**
	TOTAL HI				**1E+03**
Site Monitoring Well	Arsenic	NA	NA	4.0	NC
	Cadmium	NA	NA	4.0	NC
MW-03	Copper	10	NA	4.0	**3E+00**
	Cyanide	8	NA	0.3	**3E+01**
	Lead	69	49	4.0	**2E+01**
Monitoring well #3 below main embankment	Mercury	2.1	NA	0.1	**2E+01**
	Selenium	NA	NA	9.0	NC
	Silver	NA	NA	9.0	NC
	Zinc	NA	70	1.0	**7E+01**
	TOTAL HI				**1E+02**
Site Monitoring Well	Arsenic	NA	NA	4.0	NC
	Cadmium	NA	NA	4.0	NC
MW-04	Copper	15	NA	4.0	**4E+00**
	Cyanide	11,816	NA	0.3	**5E+04**
	Lead	120	58	4.0	**3E+01**
Monitoring well #4 below main embankment	Mercury	0.7	NA	0.1	**7E+00**
	Selenium	NA	NA	9.0	NC
	Silver	NA	NA	9.0	NC
	Zinc	NA	200	1.0	**2E+02**
	TOTAL HI				**5E+04**
Site Monitoring Well	Arsenic	NA	NA	4.0	NC
	Cadmium	NA	NA	4.0	NC
MW-05	Copper	15	NA	4.0	**4E+00**
	Cyanide	37	NA	0.3	**1E+02**
	Lead	131	61	4.0	**3E+01**
Monitoring well #5 below main embankment	Mercury	2.2	NA	0.1	**2E+01**
	Selenium	NA	NA	9.0	NC
	Silver	NA	NA	9.0	NC
	Zinc	NA	1,900	1.0	**2E+03**
	TOTAL HI				**2E+03**
Site Monitoring Well	Arsenic	349	9.0	4.0	**9E+01**
	Cadmium	16	3.3	4.0	**4E+00**
MW-06	Copper	190	20	4.0	**5E+01**
	Cyanide	1,552	NA	0.3	**6E+03**
	Lead	142	37	4.0	**4E+01**
Monitoring well #6 below main embankment	Mercury	0.5	0.2	0.1	**5E+00**
	Selenium	15	15	9.0	**2E+00**
	Silver	17	10	9.0	**2E+00**
	Zinc	2,790	73	1.0	**3E+03**
	TOTAL HI				**9E+03**
Background	Arsenic	4	3.6	4.0	9E-01
	Cadmium	3	3.3	4.0	8E-01
RT-1	Copper	30	171	4.0	**8E+00**
	Cyanide	5	NA	0.3	**2E+01**
	Lead	627	41	4.0	**2E+02**
	Mercury	0.2	0.2	0.1	**2E+00**
Upstream monitoring well	Selenium	3	3	9.0	3E-01
	Silver	2	10	9.0	3E-01
	Zinc	136	20	1.0	**1E+02**
	TOTAL HI				**3E+02**

NA = Not Available
NC = Not Calculated

Concentrations are calculated using 1/2 the detection limit for non-detects "U".
If well-specific hardness is not available, a well hardness of 200 mg/L is assumed.
If hardness is greater than AWQC upper hardness limit, the upper hardness limit is used to calulate the AWQC.
HQs in exceedance of the benchmark are shown in boldface type.

***Seep concentrations are estimated using available groundwater data.**

Table 7-10
SeepWater* Hazard Quotients (HQs) for Plants

Screening Ecological Risk Assessment for Richardson Flat Tailings

Station Information	Parameter	Groundwater EPC (ug/L)		Plant Screening Benchmark for Solutions (ug/L)	Plant HQ
		Total	Dissolved		
	Aluminum	80,700	49.6	300	**3E+02**
Site Monitoring Well	Arsenic	76	3.6	1	**8E+01**
	Beryllium	3	1.8	500	7E-03
	Cadmium	42	3.3	100	4E-01
MW-01	Chromium	95	7.8	50	**2E+00**
	Cobalt	46	10.0	60	8E-01
	Copper	1,583	20	60	**3E+01**
	Lead	88	92	20	**4E+00**
	Manganese	590	33,000	4,000	1E-01
Monitoring well #1 below	Mercury	0	0.2	5	5E-02
main embankment	Selenium	15	15	700	2E-02
	Zinc	650	108	400	**2E+00**
	TOTAL HI				**4E+02**
	Aluminum	NA	NA	300	NC
Site Monitoring Well	Arsenic	NA	NA	1	NC
	Beryllium	NA	NA	500	NC
	Cadmium	NA	NA	100	NC
MW-03	Chromium	NA	NA	50	NC
	Cobalt	NA	NA	60	NC
	Copper	10	NA	60	2E-01
	Lead	69	49	20	**3E+00**
	Manganese	3,967	7,536	4,000	1E+00
Monitoring well #3 below	Mercury	2	NA	5	4E-01
main embankment	Selenium	NA	NA	700	NC
	Zinc	NA	70	400	2E-01
	TOTAL HI				**5E+00**
	Aluminum	NA	NA	300	NC
Site Monitoring Well	Arsenic	NA	NA	1	NC
	Beryllium	NA	NA	500	NC
	Cadmium	NA	NA	100	NC
MW-04	Chromium	NA	NA	50	NC
	Cobalt	NA	NA	60	NC
	Copper	15	NA	60	3E-01
	Lead	120	58	20	**6E+00**
	Manganese	12,000	6,797	4,000	**3E+00**
Monitoring well #4 below	Mercury	1	NA	5	1E-01
main embankment	Selenium	NA	NA	700	NC
	Zinc	NA	200	400	5E-01
	TOTAL HI				**1E+01**
	Aluminum	NA	NA	300	NC
Site Monitoring Well	Arsenic	NA	NA	1	NC
	Beryllium	NA	NA	500	NC
	Cadmium	NA	NA	100	NC
MW-05	Chromium	NA	NA	50	NC
	Cobalt	NA	NA	60	NC
	Copper	15	NA	60	3E-01
	Lead	131	61	20	**7E+00**
	Manganese	16,000	13,368	4,000	**4E+00**
Monitoring well #5 below	Mercury	2	NA	5	4E-01
main embankment	Selenium	NA	NA	700	NC
	Zinc	NA	1,900	400	**5E+00**
	TOTAL HI				**2E+01**
	Aluminum	4,920	68.5	300	**2E+01**
Site Monitoring Well	Arsenic	349	9.0	1	**3E+02**
	Beryllium	5	3.7	500	1E-02
	Cadmium	16	3.3	100	2E-01
MW-06	Chromium	42	7.8	50	8E-01
	Cobalt	80	67.0	60	1E+00
	Copper	190	20	60	**3E+00**
	Lead	142	37	20	**7E+00**
	Manganese	3,716	4,246	4,000	9E-01
Monitoring well #6 below	Mercury	1	0.2	5	1E-01
main embankment	Selenium	15	15	700	2E-02
	Zinc	2,790	73	400	**7E+00**
	TOTAL HI				**4E+02**
	Aluminum	15,700	191.0	300	**5E+01**
Site Monitoring Well	Arsenic	4	3.6	1	**4E+00**
	Beryllium	1	0.9	500	3E-03
	Cadmium	3	3.3	100	3E-02
RT-1	Chromium	11	7.8	50	2E-01
	Cobalt	11	6.0	60	2E-01
	Copper	30	171	60	5E-01
	Lead	627	41	20	**3E+01**
	Manganese	162	20	4,000	4E-02
Upstream monitoring well	Mercury	0	0.2	5	4E-02
	Selenium	3	3	700	4E-03
	Zinc	136	20	400	3E-01
	TOTAL HI				**9E+01**

NA = Not Available
NC = Not Calculated

Concentrations are calculated using 1/2 the detection limit for non-detects "U"
HQs in exceedance of the benchmark are shown in boldface type.

***Seep concentrations are estimated using available groundwater data.**

Table 7-11
Summary of Screening Level Ecological Risk Assessment Results

Screening Ecological Risk Assessment for Richardson Flat Tailings

Exposure Medium	Receptor	Exposure Pathway	Exposure Unit with Risks	COPCs	Range of HQ or HI Values	Further Evaluation (Yes/No)
Surface Water	Aquatic Receptors	Direct Contact	Silver Creek upstream > Silver Creek downstream > South Diversion Ditch	Aluminum, arsenic, cadmium, chromium, copper, lead, mercury, selenium and zinc	HQ ≤ 1 to 200 (Total Acute) HQ ≤ 1 to 500 (Total Chronic) HQ ≤ 1 to 200 (Dissolved Acute) HQ ≤ 1 to 400 (Dissolved Chronic)	Yes for South Diversion Ditch and Wetlands
	Amphibians	Direct Contact	Silver Creek upstream > Silver Creek downstream > South Diversion Ditch > Unnamed drainage > ponded water. Wetlands unknown.	Arsenic, cadmium, copper, cyanide, lead, mercury and zinc	HQ ≤ 1 to 100,000	Yes for South Diversion Ditch and Wetlands
	Avian Wildlife	Ingestion	None	None	All HI ≤ 1 (NOAEL) All HI ≤ 1 (LOAEL)	No
	Mammalian Wildlife	Ingestion	Silver Creek Upstream	Lead	≤ 1 to 4 HI (NOAEL) All HI ≤ 1 (LOAEL)	No
Seeps	Aquatic Receptors	Direct Contact	Groundwater at main embankment > upgradient groundwater	Aluminum, arsenic, cadmium, chromium, copper, cyanide, lead, mercury, selenium and zinc	HQ ≤ 1 to 500 (Total Acute) HQ ≤ 1 to 2,000 (Total Chronic) HQ ≤ 1 to 9 (Dissolved Acute) HQ ≤ 1 to 20 (Dissolved Chronic)	Yes
	Amphibians	Direct Contact	Groundwater at main embankment > upgradient groundwater	Arsenic, cadmium, copper, cyanide, lead, mercury, selenium, and zinc	HQ ≤ 1 to 50,000	Yes
	Plants	Direct Contact	Groundwater at main embankment > upgradient groundwater	Aluminum, arsenic, chromium, copper, lead, manganese, and zinc	HQ ≤ 1 to 300	Yes
Seeps	Avian Wildlife	Ingestion	None	None	All HI ≤ 1 (NOAEL) All HI ≤ 1 (LOAEL)	No
	Mammalian Wildlife	Ingestion	Upgradient groundwater	Lead	HI ≤ 1 to 3 (NOAEL) All HI ≤ 1 (LOAEL)	No
Sediment	Benthic Invertebrates	Direct Contact	Silver Creek upstream > Silver Creek downstream > South Diversion Ditch > Wetlands	Aluminum, antimony, arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel, silver, zinc	HQ ≤ 1 to 700 (Low Benchmark) HQ ≤ 1 to 300 (High Benchmark)	Yes for South Diversion Ditch and Wetlands

Table 7-11
Summary of Screening Level Ecological Risk Assessment Results

Screening Ecological Risk Assessment for Richardson Flat Tailings

Exposure Medium	Receptor	Exposure Pathway	Exposure Unit with Risks	COPCs	Range of HQ or HI Values	Further Evaluation (Yes/No)
	Avian Wildlife	Incidental Ingestion	Silver Creek Upstream >Silver Creek Downstream >`Wetlands area > South Diversion Ditch	Aluminum, arsenic, cadmium, lead, zinc	HI = 10 to 80 (NOAEL) HI = 3 to 40 (LOAEL)	Yes for Wetlands Area and South Diversion Ditch
	Mammalian Wildlife	Incidental Ingestion	Silver Creek Upstream >Silver Creek Downstream = Wetlands area > South Diversion Ditch	Aluminum, antimony, arsenic, lead, and thallium	HI = 30 to 100 (NOAEL) HI = 5 to 50 (LOAEL)	Yes for Wetlands Area and South Diversion Ditch
Soil	Plants	Direct Contact	Tailings > Off-Impoundment > On-impoundment > background	Aluminum, antimony, arsenic, cadmium, chromium copper, lead, selenium, silver, zinc	HQ ≤ 1 to 500 (Low Benchmark) HQ ≤ 1 to 60 (High Benchmark)	Yes
	Soil Fauna	Direct Contact	Tailings > Off-Impoundment > On-impoundment > background	Aluminum, arsenic, cadmium, chromium copper, lead, mercury, selenium, zinc	HQ ≤ 1 to 200 (Low Benchmark) HQ ≤ 1 to 5 (High Benchmark)	Yes
	Avian Wildlife	Incidental Ingestion	Tailings > On-Impoundment > Off-impoundment > background	Aluminum, arsenic, barium, chromium, cadmium, copper, lead, mercury, selenium, and zinc	HI ≤ 1 to 200 (NOAEL) HI ≤ 1 to 70 (LOAEL)	Yes
	Mammalian Wildlife	Incidental Ingestion	Tailings > On-Impoundment > Off-impoundment > background	Aluminum, antimony, arsenic, barium, cadmium, lead, selenium, and zinc	HI ≤ 1 to 8,000 (NOAEL) HI ≤ 1 to 3,000 (LOAEL)	Yes
Food Chain Items	Avian & Mammalian Piscivores	Ingestion of Fish	Silver Creek upstream > Silver Creek downstream > South Diversion Ditch > Wetlands	Aluminum, antimony, arsenic, cadmium, lead. selenium, and zinc	HIs = 4,000 to 50,000 (NOAEL) HIs = 1,000 to 20,000 (LOAEL)	Yes for wetland and south diversion ditch
	Avian Aquatic Insectivores	Ingestion of Benthic Invertebrates	Silver Creek upstream > Silver Creek downstream > South Diversion Ditch > Wetlands	Cadmium, lead and zinc	HIs = 2,000 to 6,000 (NOAEL) HIs = 200 to 1,000 (LOAEL)	Yes for wetland and south diversion ditch
Food Chain Items	Avian & Mammalian Herbivores	Ingestion of Plants	Tailings > Off-Impoundment soils > On-impoundment soils > Background	Lead, selenium, and zinc	HI ≤ 1 to 40 (NOAEL) HI ≤ 1 to 20 (LOAEL)	Yes

Table 7-11
Summary of Screening Level Ecological Risk Assessment Results

Screening Ecological Risk Assessment for Richardson Flat Tailings

Exposure Medium	Receptor	Exposure Pathway	Exposure Unit with Risks	COPCs	Range of HQ or HI Values	Further Evaluation (Yes/No)
	Avian & Mammalian Terrestrial Insectivores	Ingestion of Terrestrial Invertebrates	Tailings > Off-Impoundment soils > On-impoundment soils > Background	Arsenic, cadmium, copper, lead, mercury, selenium, and zinc	HI = 100 to 20,000 (NOAEL) HI = 30 to 6,000 (LOAEL)	Yes
	Avian & Mammalian Carnivores	Ingestion of Small Mammals	Tailings > Off-Impoundment soils > On-impoundment soils > Background	Cadmium, lead, and selenium	HI = 3 to 200 (NOAEL) HI ≤1 to 20 (LOAEL)	Yes

Table 8-1
Principle Sources of Uncertainty

Screening Level Ecological Risk Assessment for the Richardson Flats Tailings Site

Source of Uncertainty	Direction of Effect	Explanation
		Problem Formulation
Use of specific wildlife species as representative species	Unknown	The specific species selected may not be truly representative for all species within the RFT Site. The species chosen were selected to represent general trophic levels and feeding strategies.
Omission of reptiles as representative species	Unknown	Toxicity information for quantitative evaluation of risks for reptiles associated with ingestion of and direct contact with COPCs could not be identified and specific representative species were not selected. The sensitivity of these organisms relative to birds, mammals, and amphibians is unknown.
Omission of food web pathways	Underestimate	The food web pathways for benthic invertebrate and fish ingestion could not be evaluated as prey tissue data is not available and could not be estimated. The lack of prey data results in underestimation of risks.
Limited number of pathways	Underestimate	Not all possible exposure pathways are evaluated in the SERA. Omission of some pathways may underestimate exposures and risks.
		Exposure Assessment
Use of UCL95 concentrations as exposure point concentrations	Unknown	The UCL95 concentrations of COPCs are used as exposure point concentrations for wildlife receptors. These concentrations are assumed to be uniform across the Site area. Actual exposures on a location-by-location basis may be lower or higher.
Exposure model parameters for wildlife receptors	Unknown	Exposure assumptions for wildlife are based on literature reported information. Some assumptions are based on data for laboratory test organisms. The true factors could be higher or lower. Actual diet compositions of wild organisms vary depending on feeding preferences and prey availability.
Metal bioavailability	Overestimate	Absorption efficiency for all COCs for wildlife doses via ingestion of sediments are assumed to be 100%. Absorption efficiency for most metals are typically less than 100%.
Habitat utilization by wildlife	Overestimate	Wildlife are assumed to use all sampling locations in constant proportion to the total foraging area. Animals are most likely habitat selective.
Calculation of average daily doses for wildlife species	Overestimate	The bioavailability of chemicals in prey is assumed to be equivalent to the bioavailability of the COC in laboratory test media. This assumption is conservative as laboratory testing purposely includes doses required to ensure maximum uptake of chemicals.
		Effects Assessment
Use of non site-specific screening benchmarks	Unknown	Screening level benchmarks were identified for literature studies. The actual site-specific toxicity of COPCs may be higher or lower.
Absence of toxicity benchmarks	Underestimate	Toxicity benchmarks could not be identified for all COPCs. Wildlife TRVs could not be derived for all COCs for all receptors, therefore risks may be underestimated for these COPCs.
Antagonistic, synergistic, and additive effects of chemical mixtures	Unknown	Effects associated with exposures to multiple chemicals are unknown. For screening purposes additivity is assumed for wildlife.
		Risk Characterization
Risks to wildlife populations	Overestimate	The risks to wildlife (hazard quotients) represent risks for individuals. Natural populations are resilient and the death or impairment of a few individuals may not threaten the integrity of the population.
Risks to reptiles	Unknown	The risk assessment assumes that protection of birds, mammals and amphibians will protect reptiles as well. Currently, it is not possible to assess the relative sensitivity and the validity of this assumption.

Table 9-1
Summary of Data Gaps for Ecological Risk Assessment

Screening Level Ecological Risk Assessment for the Richardson Flat Tailings

Exposure Area	Data Type	Data Gaps	Data Collection
Wetland Area and Embankment	**Analytical Data**	Surface water data from wetlands area is not available. Extent of contamination in surface water is unknown.	Collect surface water samples from wetland area and analyze for target analyte list (TAL) metals. Also collect information on water quality.
		Sediment data from the wetland area is limited to four samples collected by E&E in 1993 (Table 3-9)	Collect additional sediment samples for analyses of TAL metals to better understand current extent of contamination after recent site activities. Complete concurrent analyses of pore water concentrations of metals in sediments.
		Seep water data from the main embankment area is not available. Risks in the SERA are estimated from groundwater data.	Collect seep samples and analyze for TAL metals as well as locate and identify location and extent of seeps along embankment.
	Biological Data	Information on the type of wetland extent of possible habitat is unknown. Use of the wetland area by wildlife and aquatic receptors is unknown.	Collect information on the extent and nature of the wetlands habitat present. This would include qualitative information on vegetative cover that would be used to identify possible use by wildlife and aquatic receptors. Complete a qualitative sampling of the wetlands area (concurrently with surface water, sediment and sediment pore water samples) to identify presence absence of macroinvertebrates. Species will be identified to lowest taxonomic level possible.

Table 9-1
Summary of Data Gaps for Ecological Risk Assessment

Screening Level Ecological Risk Assessment for the Richardson Flat Tailings

Exposure Area	Data Type	Data Gaps	Data Collection
Wetlands and Embankment	**Toxicological Data**	The SERA predicts that surface water, seep water and sediments of the wetland area are toxic to aquatic receptors however site-specific toxicity is unknown.	Consider toxicity testing of seep water, sediment, and/or sediment pore water in consideration of habitat information obtained and site-specific needs to reduce the conservative screening estimates of the SERA. Testing should be completed concurrently with sampling and analyses for analytical parameters and biological sampling.
	Biological Tissue Data	The SERA predicts risks for wildlife species consuming, benthic invertebrates and fish from the wetlands area. The site-specific metals concentrations in food items is unknown.	Collect benthic organisms and fish (if present) from wetlands are for tissue analyses of TAL metals. Samples should be collected concurrently with other environmental media samples.
South Diversion Ditch	**Analytical Data**	Current sampling of the sediments of the South Diversion ditch is adequate for establishing extent of contamination. It may however be necessary to collect further samples for analyses concurrently with any toxicity testing, benthic invertebrate sampling, or biological tissue sampling.	Collect concurrent analyses metals with any sediment, sediment pore water, benthic invertebrate community survey and/or biological tissue sampling. Sampling and analyses of TAL metals in sediment pore water may be useful in understanding the bioavailability and potential toxicity of metals measured in bulk sediment samples
South Diversion Ditch	**Biological Data**	Information on the type of habitat is unknown. Potential use of the diversion ditch area by wildlife and aquatic receptors is unknown.	Collect information on the extent and nature of the habitat present. This would include qualitative information on vegetative cover that would be used to identify possible use by wildlife and aquatic receptors. Complete a qualitative sampling of the diversion ditch (concurrently with sediment and sediment pore water samples) to identify presence absence of macroinvertebrates. Species will be identified to lowest taxonomic level possible.

Table 9-1
Summary of Data Gaps for Ecological Risk Assessment

Screening Level Ecological Risk Assessment for the Richardson Flat Tailings

Exposure Area	Data Type	Data Gaps	Data Collection
South Diversion Ditch	**Toxicological Data**	The SERA predicts that surface water and sediments of the South Diversion ditch toxic to aquatic receptors however site-specific toxicity is unknown.	Consider toxicity testing of sediment, and/or sediment pore water in consideration of habitat information obtained and site-specific needs to reduce the conservative screening estimates of the SERA. Concurrent samples of media should be analyzed for TAL metals with analyses coordinated with any biological sampling or sampling of biological tissue.
South Diversion Ditch	**Biological Tissue Data**	The SERA predicts risks for wildlife species consuming, benthic invertebrates and fish from the South Diversion Ditch. The site-specific metals concentrations in food items is unknown.	Collect benthic organisms and fish (if present) for tissue analyses of TAL metals. Sediment and/or sediment pore water samples should be collected concurrently and analyzed for TAL metals.
On and Off-Site *Impoundment* Soils	**Analytical Data**	Current sampling of the soils on and off the main impoundment have been analyzed for an inconsistent set of analyses.	Analyze future monitoring samples for TAL list. Analyze samples collected for concurrent analyses of tissues for TAL list.
	Other Data	Potential risks are associated with the depth and extent of soil cover.	Map extent of soil cover off and on the main impoundment. Evaluate risks in the ERA considering the depth of soil cover in relation to the types of plant cover present and root zone for such.
	Biological Data	Information on the type of habitat is unknown. Potential use of the on and off impoundment soils areas area by wildlife is unknown.	Map and characterize the type of vegetative cover. Characterize habitat and identify possible wildlife receptors.
	Toxicological Data	The SERA predicts that on and off impoundment soils are potentially toxic to plants and soil invertebrates however site-specific toxicity is unknown.	Consider toxicity testing of soils with earthworms and/or plants in consideration of vegetation and soil cover information obtained and site-specific needs to reduce the conservative screening estimates of the SERA. Testing should be completed concurrently with sampling and analyses for analytical parameters and biological sampling.
	Biological Tissue Data	The SERA predicts risks for wildlife species consuming, plants, soil invertebrates and small mammals. The site-specific metals concentrations in food items is unknown.	Collect plants and soil invertebrates for tissue analyses of TAL metals. Soil samples should be collected concurrently and analyzed for TAL metals.

APPENDICES

-DRAFT-

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

APPENDIX A

RAW DATA SUMMARY

electronic data will be provided upon request

-DRAFT-

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

APPENDIX B

WILDLIFE EXPOSURE FACTORS

Red Fox
Vulpes vulpes

Parameter	Symbol	Reported Values	References	Values Identified for ERA
Habitat		Habitats are diverse. Red fox prefer areas with broken and diverse upland habitats. They are rare in pine forests, moist conifer forests and semiarid grasslands and deserts.	USEPA, 1993	
Body Weight (kg wet weight)	BW	5.25 - Mean - adult males in spring - Illinois 4.13 - Mean - adult females in spring - Illinois 4.82 - Mean - adult males in fall - Iowa 3.94 - Mean - adult females in fall - Iowa 2.95 to 7.04 - Range of means	USEPA, 1993	Mean of reported means: 4.54
Food Ingestion Rate (kg wet weight/day)	IR_{food}	0.069 g/g-day (wet weight) - Mean - nonbreeding adults - North Dakota - captive = 0.31 kg/day (based on BW of 4.54 kg)	USEPA, 1993	Reported value used: 0.31
Water Ingestion Rate (L/day)	IR_{water}	Species-specific values are not available. Can be estimated based on the following equation: $IR_{water} = 0.099*BW^{0.90}$	USEPA, 1993	Estimated from equation: 0.39
Soil Ingestion Rate (kg dry weight/day)	IR_{soil}	Ingestion of soil (I_{soil}) as percentage of food intake (kg sediment dry weight/kg food dry weight) is reported at 2.8%. I_{sed} equal to 0.028.	Beyer, 1994	$IR_{soil} = IR_{food}*0.27*I_{soil.}$ Where 0.27 (kg food dry weight /kg food wet weight) = wet weight to dry weight conversion factor for food assuming 27% dry matter in food: 0.0023
Dietary Composition (fraction wet volume)	df	The red fox feeds on both plants and animals with most of its diet composed of small mammals, birds, insects and fruit.	USEPA, 1993	Fraction fish= $df_{mammals}$ = 0.90 Fraction plants = df_{plant} = 0.1 27% solids in diet based on weighted average.
Home Range Size (ha)	HR	1,611 - Mean -adult both sexes - British Columbia 1,967 - Mean - adult male - British Columbia 1,137 - Mean - adult female - British Columbia 699 - Mean - adult female - spring - Minnesota 717 - Mean - adult male - Wisconsin 96 - Mean - adult female - Wisconsin	USEPA, 1993	Mean of reported values: 1,038
Seasonal Use				

Masked Shrew *Sorex cinereus*				
Parameter	**Symbol**	**Reported Values**	**References**	**Values Identified for ERA**
Habitat		Masked shrews are the most common shrews in moist forests, open country, and brush of the northern United States. High-metabolic rates require cool, moist areas.	Zeveloff, 1988	
Body Weight (kg wet weight)	BW	2.4-7.8 g (mean of range = 5.1g) 4-7g (mean of range = 5.5g)	Whitaker, 1980 Burt & Grossenheider, 1976	Mean of reported means: 0.0053
Food Ingestion Rate (kg wet weight/day)	IR_{food}	0.00795 - Mean - adults both sexes - Ohio laboratory 0.62 g/g- day = 0.01 kg/d = Mean - adults both sexes - Ohio lab	USEPA, 1993 [a]	Mean of mean values: 0.0090
Water Ingestion Rate (L/day)	IR_{water}	Can be estimated based on the following equation: $IR_{water} = 0.099*BW^{0.90}$	USEPA, 1993 [a]	Reported mean selected: 0.00089
Soil Ingestion Rate (kg dry weight/day)	IR_{soil}	Ingestion of soil (I_{soil}) as percentage of food intake (kg soil dry weight/kg food dry weight) is reported at 13%. Value reported for short-tail shrew.	Talmage & Walton, 1993	$IR_{soil} = IR_{food}*0.32*I_{soil.}$ Where 0.32 (kg food dry weight /kg food wet weight) = wet weight to dry weight conversion factor for food assuming 32% dry matter in food: 0.00037
Dietary Composition (fraction wet volume)	df	The masked shrew is primarily feeds on insects with beetles, flies, and ants comprising most of their diet. They also consume small vertebrates, such as salamanders, and some vegetation.	Zeveloff, 1988	Fraction soil invertebrates = $d_{soilinverts} = 0.32$ Fraction terr invertebrates = $df_{terrinverts} = 0.53$ Fraction plants = $df_{plant} = 0.15$ 32% solids in diet based on weighted average.
Home Range Size (ha)	HR	0.39 - Mean - both sexes - Manitoba bog	USEPA, 1993 [a]	0.39
Seasonal Use				

a uses values established for the short-tailed shrew

Deer Mouse
Peromyscus maniculatus

Parameter	Symbol	Reported Values	References	Values Identified for ERA
Habitat		Deer mice inhabit al types of dry-land type habitats including short-grass prairies, grass-sage communities, coastal sage scrub, sand dunes, wet prairies, upland mixed and cedar forests, and deciduous forests.	USEPA, 1993	
Body Weight (kg wet weight)	BW	0.022 - Mean - adult males - North America 0.020 - Mean - adult females - North America 0.0157 - Mean - adult males 0.0148 - Mean - adult females 0.0223 - Mean - adult males 0.0211 - Mean - adult females 0.0196 - Mean - both sexes - New Hampshire	USEPA, 1993	Mean of reported means: 0.019
Food Ingestion Rate (kg wet weight/day)	IR_{food}	0.19 g/g-day(wet weight) - Mean - adult females - Canada 0.18 g/g-day (wet weight) - Mean - adult females - Canada 0.45 g/g-day - Mean - lactating females - Canada 0.38 g/g-day - Mean - lactating females - Canada 0.19 g/g-day - Mean - nonbreeding females - Virginia lab 0.22 g/g-day - Mean - nonbreeding males - Virginia lab	USEPA, 1993	Mean of reported mean values (0.268 g/g-day) for free-living adults is used converting to kg/day based on a BW of 0.019 kg: 0.005
Water Ingestion Rate (L/day)	IR_{water}	0.19 g/g-day - Mean -adults - Illinois lab Can be estimated based on the following equation: $IR_{water} = 0.099 * BW^{0.90}$	USEPA, 1993	Estimated based on equation: 0.0028
Soil Ingestion Rate (kg dry weight/day)	IR_{soil}	Ingestion of soil (I_{soil}) as percentage of food intake (kg soil dry weight/kg food dry weight) is not available for the deer mouse. Beyer reports <2% for the white-footed mouse. It is assumed that the deer mouse is similar due to a similar diet. I_{soil} is assumed to equal 0.02 or 2% of food intake.	Beyer, 1994	$IR_{soil} = IR_{food} * 0.55 * I_{soil}$ Where 0.55 (kg food dry weight /kg food wet weight) = wet weight to dry weight conversion factor for food assuming 55% dry matter in food: 0.00006
Dietary Composition (fraction wet volume)	df	Deer mice are omnivorous and opportunistic. They eat primarily seeds, arthropods, some green vegetation , roots, fruits and fungi. In Colorado short grass prairie the reported diet contains: 43% seeds, 5.4% forbs, 3.6% grasses and sedges, 2.1% shrubs, 13% beetles, 4.9% leafhoppers, 9.4% lepidopterans, and 2.0% spiders.	USEPA, 1993	Fraction plants = df_{plant} = 1.0
Home Range Size (ha)	HR	The home range of female deer mice encompass both their foraging areas and their 0.039 - Mean for adult males in summer in Utah subalpine meadow 0.027 - Mean for adult females in summer in Utah subalpine meadow 0.10 - Mean for adult males in Oregon ponderosa pines 0.075 - Mean for adult females in Oregon ponderosa pines 0.128 - Mean for adult males in Idaho desert 0.094 - Mean for adult females in Idaho desert	USEPA, 1993	Mean of means for females: 0.065
Seasonal Use		Torpor reported in winter in northern parts of range.	USEPA, 1993	

Mink *Mustela vison*				
Parameter	**Symbol**	**Reported Values**	**References**	**Values Identified for ERA**
Habitat		Mink are associated with aquatic habitats including rivers, streams, lakes, ditches, swamps, marshes and backwater areas. They prefer irregular shorelines and brushy or wooded cover adjacent to the water.	USEPA, 1993	
Body Weight (kg wet weight)	BW	1.04 - Mean - adult male - summer - Montana 1.233 - Mean - adult male - fall - Montana 0.550 - Mean - adult female- summer - Montana 0.586 - Mean - adult female - fall - Montana 0.777 - Mean - juvenile male - summer - Montana 0.533 - Mean - juvenile female - summer - Montana	USEPA, 1993	Mean of means for females: 0.556
Food Ingestion Rate (kg wet weight/day)	IR_{food}	0.13 g/g-day - Mean - captive males = 0.15 kg/day (using 1.14 kg BW) 0.12 g/g-day - Mean - farm raised males = 0.14 kg/day 0.16 g/g-day - Mean - farm raised females = 0.089 kg/day (0.556 BW)	USEPA, 1993	Mean of means for females: 0.089
Water Ingestion Rate (L/day)	IR_{water}	0.028 g/g-day = 0.022 L/day - Mean for farm raised mink.	USEPA, 1993	Reported mean selected: 0.0584
Sediment or Soil Ingestion Rate (kg dry weight/day)	$IR_{sediment}$	Ingestion of sediment (I_{sed}) or soil (I_{soil}) as percentage of food intake (kg dry weight/kg food dry weight) is not available. Assumed to be equal to 1%.		IR_{sed} (or IR_{soil}) = IR_{food}*0.25*$I_{sed/soil}$ where 0.25 (kg food dry weight /kg food wet weight) = wet weight to dry weight conversion factor for food assuming 25% dry matter in food: 0.0002
Dietary Composition (fraction wet volume)	df	Mink are opportunistic feeders taking whatever prey is abundant. In many parts of its range mammals are the most important prey but mink hunt aquatic prey as well depending on the season. In mink intestines collected from the Clark Fork River percent freqency of occurrence in samples for food items: 61.5% fish; 19.2% mammals and 26.9% aquatic invertebrates. In mink stomachs the frequency of occurrence was: 11.5% fish, and 7.2% mammals.	USEPA, 1993 RCG, Hagler Bailly, 1995	Fraction fish= df_{fish} = 0.75 Fraction aquatic invertebrates = $df_{aquinverts}$ = 0.25
Home Range Size (ha)	HR	Range size and shape depends on habitat. Shape is linear along streams and circular in marshes. Montana /riverine: 7.8 - Female mink in heavy vegetation 20.4 - Female mink in sparse vegetation	USEPA, 1993	Mean of reported values: 14.1
Seasonal Use		Mink are nocturnal and active year round.	USEPA, 1993	

American Robin
Turdus migratorius

Parameter	Symbol	Reported Values	References	Values Identified for ERA
Habitat		Breeds in moist forests, swamps, open woodlands, orchards, parks, and lawns. Forages on ground in open areas along habitat edges of streams.	USEPA, 1993 and Sample & Suter, 1994	
Body Weight (kg wet weight)	BW	0.0773 - Mean - adults - Pennsylvania 0.0862 - Mean - adult male nonbreeders - New York 0.0836 - Mean - adult female nonbreeders - New York 0.0774 - Mean - adult female breeders -New York 0.0806 - Mean - adult male breeders - New York 0.0635 to 0.103 - Range breeding adults - PA (median=0.0833)	USEPA, 1993	Mean of reported means for breeding adults: 0.0814
Food Ingestion Rate (kg wet weight/day)	IR_{food}	0.89 g/g-day (wet weight) - Mean - breeding free living male and females - California = 0.0698 kg/day (BW = 0.0823 kg) 1.52 g/g-day (wet weight) - Mean - free living adults - Kansas = 0.12 kg/day (BW = 0.055 kg)	USEPA, 1993	Mean of two reported values: 0.078
Water Ingestion Rate (L/day)	IR_{water}	Specific values for the robin are unavailable. Estimated based on following equation: $IR_{water} = 0.059*BW^{0.67}$	USEPA, 1993	Estimated from equation: 0.011
Soil Ingestion Rate (kg dry weight/day)	IR_{soil}	**Specific soil ingestion values are not available for the robin.** If soil ingestion is assumed to be proportional to the fraction of earthworms (soil invertebrates) in the diet then the reported soil ingestion for the American woodcock can be used as a basis for deriving a value for the robin.	Beyer, 1994; Sample & Suter, 1994	If the diet of the woodcock is 99% earthworms and 10.4% of their diet is soil then a robin consuming 77% earthworms will consume 8.1% soil. $I_{soil} = 0.081$ $IR_{sed} = IR_{food}*0.2*I_{sed}$ Where 0.2 (kg food dry weight /kg food wet weight) = wet weight to dry weight conversion factor for food assuming 20% dry matter in food: 0.0012
Dietary Composition (fraction wet volume)	df	Western United States: Spring: fruit 17%; invertebrates 83% Summer: fruit 29%; invertebrates 71% Fall: fruit 63%; invertebrates 37% Winter: fruit 70%; invertebrates 30%	USEPA, 1993	Diet reported for breeding season used (spring & summer). Reported fractions for seasons are averaged: Plants = $df_{plants} = 0.3$ Soil invertebrates = $df_{soilinverts} = 0.7$
Home Range Size (ha)	HR	Foraging home range from nests in summer: 0.15 - Mean - adults with nestlings 0.81 - Mean - adults with fledglings	USEPA, 1993	Mean of mean values: 0.48
Seasonal Use		Migratory in northern portion of range. Leave breeding grounds from September to November returning from February to April.	USEPA, 1993	

Greater-Sage Grouse *Centrocercus urophasianus*				
Parameter	**Symbol**	**Reported Values**	**References**	**Values Identified for ERA**
Habitat		Sagebrush plains, foothills, and mountain valleys	Utah Division of Wildlife Resources http://www.utahc	
Body Weight (kg wet weight)	BW	Males-25-30 inches in length and up to 7 pounds - N. America Females-average 20 inches and less than 3 pounds - N. America	Utah Division of Wildlife Resources http://www.utahc dc.usu.edu/rsgis2/ Search/Display.as	Average of male and female: 2.3
Food Ingestion Rate (kg wet weight/day)	IR_{food}	Specific values for the grouse are unavailable. Estimated based on following equation: IR_{food} (kg dw/day) = $0.0582*BW$ (kg ww)$^{0.651}$	USEPA, 1993	Reported mean value for free-living adults is used: 0.100
Water Ingestion Rate (L/day)	IR_{water}	Species specific values are not available. Estimated based on following equation: $IR_{water} = 0.059*BW^{0.67}$	USEPA, 1993	Estimated from equation: 1.031
Soil Ingestion Rate (kg dry weight/day)	IR_{soil}	Ingestion of soil (I_{soil}) as percentage of food intake (kg soil dry weight/kg food dry weight) is not available. Assumed to be equal to 2%.	Assumption	$IR_{soil} = IR_{food}*0.33*I_{soil}$ Where 0.33 (kg food dry weight /kg food wet weight) = wet weight to dry weight conversion factor for food assuming 33% dry matter in food: 0.0007
Dietary Composition (fraction wet volume)	df	Sage grouse eat primarily plants and flowers. They eat sagebrush leaves in the winter and clovers, dandelions, grasses, and other plants in the summer. Juveniles occasionally eat seeds and insects in the summer.	Utah Division of Wildlife Resources http://www.utahc	Fraction plants = $df_{plants} = 1.0$
Home Range Size	HR	as much as 800 square miles	http://cascadia.ti	
Seasonal Use		The Greater-Sage Grouse is a permanent resident of Oregon, Washington, Idaho, Nevada, Utah, Colorado, Wyoming, Montana, California, North and South Dakota. The males arrive at "strutting grounds" during March and April. Females arrive here in early	Utah Division of Wildlife Resources http://www.utahc	

American Kestrel *Falco sparverius*				
Parameter	**Symbol**	**Reported Values**	**References**	**Values Identified for ERA**
Habitat		Open deserts, semi-open areas, edges of groves and urban areas	USEPA, 1993	
Body Weight (kg wet weight)	BW	0.115 - Mean - females - fall - California 0.103 - Mean - males - fall - California 0.124 - Mean - laying females - Utah 0.127 - Mean - females - fall - Utah 0.108 - Mean - incubating males - Utah 0.111 - Mean - males - fall - Utah	USEPA, 1993	Mean of reported means: 0.115
Food Ingestion Rate (kg wet weight/day)	IR_{food}	0.29 g/g -day (wet weight) - Mean - free-living adults - winter - California 0.31 g/g-day (wet weight) - seminatural enclosed adults - Ohio	USEPA, 1993	Reported mean value for free-living adults is used: 0.033
Water Ingestion Rate (L/day)	IR_{water}	Species specific values are not available. Estimated based on following equation: $IR_{water} = 0.059*BW^{0.67}$	USEPA, 1993	Estimated from equation: 0.014
Soil Ingestion Rate (kg dry weight/day)	IR_{soil}	Ingestion of soil (I_{soil}) as percentage of food intake (kg soil dry weight/kg food dry weight) is not available. Assumed to be equal to 1%.	Assumption	$IR_{soil} = IR_{food}*0.33*I_{soil}$ Where 0.33 (kg food dry weight /kg food wet weight) = wet weight to dry weight conversion factor for food assuming 33% dry matter in food: 0.0001
Dietary Composition (fraction wet volume)	df	Kestrels prey on a variety of small animals including invertebrates(worms, spiders, scorpions, beetles), amphibians, reptiles and small to medium-sized birds and mammals. Reported diet in California open areas: Invertebrates: 32.6%, mammals: 31.7%, birds: 30.3%, reptiles: 1.9 %, and other 3.5%.	USEPA, 1993	Fraction terr. invertebrates = $df_{terrinverts} = 0.33$ Fraction small mammals = $df_{mammals} = 0.67$ 33% solids in diet based on weighted average.
Home Range Size (ha)	HR	202 - Mean - adults - summer - Wyoming 131- Mean - adults - summer - Michigan 21 to 500 - Range for summer 9.7 to 42 - Range for winter	USEPA, 1993	Mean of reported means for summer: 167
Seasonal Use		The American Kestrel is a year-round resident over most of the United States; but is migratory in the northern-most portion of its range. In Utah the American Kestrel migrates in early September to early November and in Wyoming it returns in mid-April.	USEPA, 1993	

Mallard Duck *Anas platyrhynchos*				
Parameter	**Symbol**	**Reported Values**	**References**	**Values Identified for ERA**
Habitat		Natural bottomland wetlands and rivers, reservoirs, and ponds in winter. Dense grassy vegetation with height of at least one-half meter, usually within a few kilometers of water, for nesting	USEPA, 1993	
Body Weight (kg wet weight)	BW	1.225 - Mean - adult male 1.043 - Mean - adult female 1.043 to 1.814 - Range	USEPA, 1993	1.13
Food Ingestion Rate (kg wet weight/day)	IR_{food}	Species specific values are not available. Can be estimated based on following equation: IR_{food}=(0.0582*$BW^{0.651}$) / 0.2 Where: 0.2 = dry weight to wet weight conversion factor assuming 20% dry matter in diet.	USEPA, 1993	Estimated from equation: 0.32
Water Ingestion Rate **(L/day)**	IR_{water}	Values not reported. **Estimated based on following equation:** IR_{water} =0.059*$BW^{0.67}$	USEPA, 1993	Estimated from equation: 0.064
Sediment Ingestion Rate (kg dry weight/day)	IR_{sed}	Ingestion of sediment (I_{sed}) as percentage of food intake (kg sediment dry weight/kg food dry weight) reported at 3.3%.	Beyer, 1994	IR_{sed} = IR_{food}*0.145*I_{sed} **Where 0.145 (kg food dry weight /kg food wet weight) = wet weight** to dry weight conversion factor for food assuming 14.5% dry matter in food: 0.0015
Dietary Composition (fraction wet volume)	df	South central North Dakota/prairie potholes. Spring breeding season: Invertebrates 74.7% ; plant material 25.3% Louisiana coastal marsh in winter Snails 1.05%; plant material 92.2% and other 6.8%	USEPA, 1993 USEPA, 1993	Diet reported for breeding season used because this is when exposures for mallards would occur at the CFR OU. Aquatic vegetation = df_{aveg} = 0.25 Aquatic invertebrates = $df_{aquinverts}$ = 0.75 14.5% solids in diet based on weighted average.
Home Range Size (ha)	HR	468 - Mean - adult female - North Dakota 111 - Mean - laying female - North Dakota 540 - Mean - adult female - Minnesota 620 - Mean - adult male Minnesota 40 to 1,440 - Range	USEPA, 1993	Mean of reported mean values for adult females: 435
Seasonal Use		Migratory in northern portion of range. Leave breeding grounds by November returning from mid-March to mid-May.	USEPA, 1993	

Belted Kingfisher

Ceryle alcyon

Parameter	Symbol	Reported Values	References	Values Identified for ERA
Habitat		Forages on ground in open areas along habitat edges of streams, rivers ponds and lakes where fish concentrations are greatest. Nests in burrows that are devoid of vegetation.	USEPA, 1993	
Body Weight (kg wet weight)	BW	0.148 - Mean - adults - Pennsylvania 0.136 - Mean - adults - Pennsylvania 0.158 - Mean - adults - Ohio	USEPA, 1993	Mean of reported means: 0.147
Food Ingestion Rate (kg wet weight/day)	IR_{food}	0.5 g/g-day - Mean - adults - northcentral lower Michigan	USEPA, 1993	Mean value: 0.07
Water Ingestion Rate (L/day)	IR_{water}	Specific values not available. Estimated based on following equation: $IR_{water} = 0.059 * BW^{0.67}$	USEPA, 1993	Estimated from equation: 0.016
Sediment Ingestion Rate (kg dry weight/day)	IR_{sed}	Ingestion of sediment (I_{sed}) or soil (I_{soil}) as percentage of food intake (kg dry weight/kg food dry weight) is not available. Assumed to be equal to 1%.	Assumption	IR_{sed} (or IR_{soil}) = IRfood*0.27*$I_{sed/soil}$ Where 0.27 (kg food dry weight /kg food wet weight) = wet weight to dry weight conversion factor for food assuming 27% dry matter in food: 0.0002
Dietary Composition (fraction wet volume)	df	Michigan/trout streams: Game fish: 43% Forage fish: 15% Unidentified fish: 1% Invertebrates: 41%	USEPA, 1993	Fraction fish = df_{fish} =0.59 Fraction aquatic invertebrates = $df_{aquinverts}$ = 0.41
Home Range Size	HR	During the spring and early summer the breeding pairs defend both the territory including both their nest site and their foraging area. By autumn each bird defends an individual feeding territory only. Breeding territories can be more than twice as long as the feeding territory. Foraging territory is inversely related to prey abundance.	USEPA, 1993	No Info
Foraging Distance (km)		Foraging distance in early summer (breeding pairs): 2.19 - Mean - Pennsylvania 1.03 - Mean - Ohio/streams 1.03 - Mean - southwest Ohio/streams	USEPA, 1993	Mean of means for breeding pairs: 1.42
Seasonal Use		Migratory in northern portion of range. Leave breeding grounds from October to December returning from February to April.	USEPA, 1993	

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APPENDIX C

ESTIMATION OF FOOD ITEM TISSUE CONCENTRATIONS

Plants
Earthworms
Small Mammals
Benthic Invertebrates

APPENDIX C

Estimation of Terrestrial Plant Tissue Concentrations from Site Soil and Tailings Data

Screening Ecological Risk Assessment for the Richardson Flat Tailings Site

Location	COPC	Detect Freq	Min	Max	Geomean	Mean	Stdev	UCL95		EPC	BAF Parameters		Plant Conc (mg/kg dw)	Plant Conc (mg/kg ww)
								Norm	LogNorm		B_0	B_1		
Background Soils	Arsenic	11/11	6.70	14.00	8.52	8.77	2.35	10.05	10.14	10.14	-1.992	0.564	0.50	0.27
	Barium	3/3	213.00	265.00	234.00	235.00	26.91	280.36	292.98	265.00	na	na	na	na
	Cadmium	1/3	0.25	1.00	0.40	0.50	0.43	1.23	200.13	1.00	-0.476	0.546	0.62	0.33
	Chromium	3/3	20.00	23.00	21.63	21.67	1.53	24.24	24.92	23.00	na	na	na	na
	Copper	3/3	15.00	29.00	19.09	20.00	7.81	33.17	78.00	29.00	0.669	0.394	7.36	3.90
	Lead	11/11	22.00	98.00	36.74	41.91	25.65	55.91	58.67	58.67	-1.328	0.561	2.60	1.38
	Mercury	1/3	0.05	0.15	0.07	0.08	0.06	0.18	2.92	0.15	-0.996	0.544	0.13	0.07
	Selenium	0/3	2.50	2.50	2.50	2.50	0.00	2.50	2.50	2.50	-0.678	1.104	1.40	0.74
	Silver	0/3	2.50	2.50	2.50	2.50	0.00	2.50	2.50	2.50	na	na	na	na
	Zinc	3/3	90.00	127.00	103.14	104.33	19.86	137.81	160.68	127.00	1.575	0.555	71.06	37.66
Off-Impoundment Soils	Arsenic	69/69	6.00	316.00	13.51	29.93	62.54	42.50	28.24	42.50	-1.992	0.564	1.13	0.60
	Barium	14/14	188.00	413.00	274.29	285.07	84.09	324.85	331.38	331.38	na	na	na	na
	Cadmium	11/14	0.25	43.00	1.25	4.98	11.67	10.50	15.30	15.30	-0.476	0.546	2.75	1.46
	Chromium	14/14	20.00	31.00	22.36	22.57	3.46	24.21	24.12	24.21	na	na	na	na
	Copper	14/14	20.00	112.00	33.35	37.79	24.43	49.34	48.74	49.34	0.669	0.394	9.07	4.81
	Lead	69/69	17.00	6265.00	90.87	523.46	1405.41	806.01	496.03	806.01	-1.328	0.561	11.32	6.00
	Mercury	4/14	0.05	3.20	0.10	0.49	1.10	1.02	1.32	1.32	-0.996	0.544	0.43	0.23
	Selenium	0/14	2.50	2.50	2.50	2.50	0.00	2.50	2.50	2.50	-0.678	1.104	1.40	0.74
	Silver	0/14	2.50	2.50	2.50	2.50	0.00	2.50	2.50	2.50	na	na	na	na
	Zinc	14/14	65.00	1800.00	183.83	319.64	478.99	546.23	550.85	550.85	1.575	0.555	160.43	85.03
On-Impoundment Soils	Aluminum	11/11	17600.00	26100.00	21834.07	22009.09	2890.83	23586.72	23738.97	23738.97	na	na	na	na
	Antimony	1/11	2.50	10.00	2.84	3.18	2.26	4.42	4.04	4.42	na	na	na	na
	Arsenic	52/58	2.50	121.00	11.27	18.80	23.81	24.05	23.78	24.05	-1.992	0.564	0.82	0.43
	Barium	13/13	175.00	365.00	236.31	243.23	64.35	275.00	277.01	277.01	na	na	na	na
	Cadmium	9/24	0.25	6.00	0.55	1.11	1.56	1.66	2.03	2.03	-0.476	0.546	0.92	0.48
	Chromium	24/24	16.00	39.00	22.21	22.63	4.83	24.31	24.25	24.31	na	na	na	na
	Copper	24/24	13.00	99.00	29.02	33.92	23.08	41.97	41.52	41.97	0.669	0.394	8.51	4.51
	Lead	58/58	13.00	3239.00	72.21	283.29	600.09	415.67	428.97	428.97	-1.328	0.561	7.94	4.21
	Mercury	7/24	0.05	1.50	0.09	0.20	0.34	0.32	0.30	0.32	-0.996	0.544	0.20	0.11
	Selenium	0/24	2.50	2.50	2.50	2.50	0.00	2.50	2.50	2.50	-0.678	1.104	1.40	0.74
	Silver	0/24	2.50	2.50	2.50	2.50	0.00	2.50	2.50	2.50	na	na	na	na
	Zinc	24/24	47.00	1010.00	131.32	212.50	261.61	303.81	314.05	314.05	1.575	0.555	117.45	62.25
Site Tailings	Aluminum	40/40	813.00	32700.00	4071.60	7541.35	9038.98	9970.97	11034.40	11034.40	na	na	na	na
	Antimony	33/40	2.50	505.00	57.88	130.15	121.20	162.72	626.21	505.00	na	na	na	na
	Arsenic	49/49	6.60	637.00	147.60	236.98	149.14	272.78	595.62	595.62	-1.992	0.564	5.01	2.66
	Cadmium	43/46	0.25	250.00	22.34	46.42	46.82	58.02	212.38	212.38	-0.476	0.546	11.58	6.14
	Chromium	39/40	2.50	111.00	18.16	22.66	19.33	27.86	28.03	28.03	na	na	na	na
	Copper	48/48	20.00	1323.00	243.01	377.00	321.34	454.92	643.91	643.91	0.669	0.394	24.96	13.23
	Lead	46/46	19.00	31600.00	2154.97	5468.63	6153.05	6992.76	44489.30	31600.00	-1.328	0.561	88.63	46.97
	Mercury	40/45	0.05	85.00	1.59	5.51	13.15	8.81	17.06	17.06	-0.996	0.544	1.73	0.92
	Selenium	26/40	0.98	24.00	6.34	8.52	5.97	10.13	12.08	12.08	-0.678	1.104	7.94	4.21
	Silver	38/46	2.50	120.00	19.31	31.17	28.20	38.15	56.45	56.45	na	na	na	na
	Zinc	47/47	97.00	33800.00	4046.74	7438.11	6630.33	9062.89	22053.08	22053.08	1.575	0.555	1243.48	659.05

BAF Parameters from BJC, 1998. Empirical Models for the Uptake of Inorganic Chemicals from Soil by Plants. BJC-OR-133. US Dept. of Energy
EPC is equal to the estimated plant concentration based on the minimum of the 95UCL and the maximum in soil.

Plant tissue concentrations were estimated using the equation: $\ln(\text{conc in plant dw}) = B_0 + B_1(\ln[\text{conc in soil dw}])$
Dry weight concentrations were converted to wet weight using a conversion factor (CF) of 0.53 [DOI, 1998]. ww = dw * CF

APPENDIX C
Estimation of Earthworm Tissue Concentrations from Site Soil and Tailings Data

Screening Ecological Risk Assessment for the Richardson Flat Tailings Site

Location	COPC	Detect Freq	Min	Max	Geomean	Mean	Stdev	UCL95		EPC	BAF Parameters		Earthworm Conc (mg/kg dw)	Earthworm Conc (mg/kg ww)
								Norm	LogNorm		B_0	B_1		
Background Soils	Arsenic	11/11	6.70	14.00	8.52	8.77	2.35	10.05	10.14	10.14	-1.421	0.706	1.24	1.04
	Barium	3/3	213.00	265.00	234.00	235.00	26.91	280.36	292.98	265.00	na	na	na	na
	Cadmium	1/3	0.25	1.00	0.40	0.50	0.43	1.23	200.13	1.00	2.114	0.795	8.28	6.96
	Chromium	3/3	20.00	23.00	21.63	21.67	1.53	24.24	24.92	23.00	0	0	1.00	0.84
	Copper	3/3	15.00	29.00	19.09	20.00	7.81	33.17	78.00	29.00	1.675	0.264	12.99	10.91
	Lead	11/11	22.00	98.00	36.74	41.91	25.65	55.91	58.67	58.67	-0.218	0.807	21.50	18.06
	Mercury	1/3	0.05	0.15	0.07	0.08	0.06	0.18	2.92	0.15	0.0781	0.3369	0.57	0.48
	Selenium	0/3	2.50	2.50	2.50	2.50	0.00	2.50	2.50	2.50	-0.075	0.733	1.82	1.53
	Silver	0/3	2.50	2.50	2.50	2.50	0.00	2.50	2.50	2.50	na	na	na	na
	Zinc	3/3	90.00	127.00	103.14	104.33	19.86	137.81	160.68	127.00	4.449	0.328	419.01	351.97
Off-Impoundment Soils	Arsenic	69/69	6.00	316.00	13.51	29.93	62.54	42.50	28.24	42.50	-1.421	0.706	3.41	2.86
	Barium	14/14	188.00	413.00	274.29	285.07	84.09	324.85	331.38	331.38	na	na	na	na
	Cadmium	11/14	0.25	43.00	1.25	4.98	11.67	10.50	15.30	15.30	2.114	0.795	72.43	60.84
	Chromium	14/14	20.00	31.00	22.36	22.57	3.46	24.21	24.12	24.21	0	0	1.00	0.84
	Copper	14/14	20.00	112.00	33.35	37.79	24.43	49.34	48.74	49.34	1.675	0.264	14.94	12.55
	Lead	69/69	17.00	6265.00	90.87	523.46	1405.41	806.01	496.03	806.01	-0.218	0.807	178.13	149.63
	Mercury	4/14	0.05	3.20	0.10	0.49	1.10	1.02	1.32	1.32	0.0781	0.3369	1.19	1.00
	Selenium	0/14	2.50	2.50	2.50	2.50	0.00	2.50	2.50	2.50	-0.075	0.733	1.82	1.53
	Silver	0/14	2.50	2.50	2.50	2.50	0.00	2.50	2.50	2.50	na	na	na	na
	Zinc	14/14	65.00	1800.00	183.83	319.64	478.99	546.23	550.85	550.85	4.449	0.328	678.01	569.53
On-Impoundment Soils	Aluminum	11/11	17600.00	26100.00	21834.07	22009.09	2890.83	23586.72	23738.97	23738.97	na	na	na	na
	Antimony	1/11	2.50	10.00	2.84	3.18	2.26	4.42	4.04	4.42	na	na	na	na
	Arsenic	52/58	2.50	121.00	11.27	18.80	23.81	24.05	23.78	24.05	-1.421	0.706	2.28	1.92
	Barium	13/13	175.00	365.00	236.31	243.23	64.35	275.00	277.01	277.01	na	na	na	na
	Cadmium	9/24	0.25	6.00	0.55	1.11	1.56	1.66	2.03	2.03	2.114	0.795	14.55	12.23
	Chromium	24/24	16.00	39.00	22.21	22.63	4.83	24.31	24.25	24.31	0	0	1.00	0.84
	Copper	24/24	13.00	99.00	29.02	33.92	23.08	41.97	41.52	41.97	1.675	0.264	14.32	12.03
	Lead	58/58	13.00	3239.00	72.21	283.29	600.09	415.67	428.97	428.97	-0.218	0.807	107.08	89.94
	Mercury	7/24	0.05	1.50	0.09	0.20	0.34	0.32	0.30	0.32	0.0781	0.3369	0.74	0.62
	Selenium	0/24	2.50	2.50	2.50	2.50	0.00	2.50	2.50	2.50	-0.075	0.733	1.82	1.53
	Silver	0/24	2.50	2.50	2.50	2.50	0.00	2.50	2.50	2.50	na	na	na	na
	Zinc	24/24	47.00	1010.00	131.32	212.50	261.61	303.81	314.05	314.05	4.449	0.328	563.89	473.67
Site Tailings	Aluminum	40/40	813.00	32700.00	4071.60	7541.35	9038.98	9970.97	11034.40	11034.40	na	na	na	na
	Antimony	33/40	2.50	505.00	57.88	130.15	121.20	162.72	626.21	505.00	na	na	na	na
	Arsenic	49/49	6.60	637.00	147.60	236.98	149.14	272.78	595.62	595.62	-1.421	0.706	21.98	18.46
	Cadmium	43/46	0.25	250.00	22.34	46.42	46.82	58.02	212.38	212.38	2.114	0.795	586.35	492.54
	Chromium	39/40	2.50	111.00	18.16	22.66	19.33	27.86	28.03	28.03	0	0	1.00	0.84
	Copper	48/48	20.00	1323.00	243.01	377.00	321.34	454.92	643.91	643.91	1.675	0.264	29.44	24.73
	Lead	46/46	19.00	31600.00	2154.97	5468.63	6153.05	6992.76	44489.30	31600.00	-0.218	0.807	3440.10	2889.69
	Mercury	40/45	0.05	85.00	1.59	5.51	13.15	8.81	17.06	17.06	0.0781	0.3369	2.81	2.36
	Selenium	26/40	0.98	24.00	6.34	8.52	5.97	10.13	12.08	12.08	-0.075	0.733	5.76	4.84
	Silver	38/46	2.50	120.00	19.31	31.17	28.20	38.15	56.45	56.45	na	na	na	na
	Zinc	47/47	97.00	33800.00	4046.74	7438.11	6630.33	9062.89	22053.08	22053.08	4.449	0.328	2274.23	1910.35

BAF Parameters from ERP, 1998. Development and Validation of Bioaccumulation Models for Earthworms. ES/ER/TM-220, US Dept of Energy
EPC is equal to the estimated earthworm concentration based on the minimum of the 95UCL and the maximum in soil.

Earthworm tissue concentrations were estimated using the equation: $\ln(\text{conc in earthworm dw}) = B_0 + B_1(\ln[\text{conc in soil dw}])$
Dry weight concentrations were converted to wet weight using a conversion factor (CF) of 0.84 [EPA, 1993]. ww = dw * CF

APPENDIX C
Estimation of Small Mammal Tissue Concentrations from Site Soil and Tailings Data

Screening Ecological Risk Assessment for the Richardson Flat Tailings Site

Location	COPC	Detect Freq	Min	Max	Geomean	Mean	Stdev	UCL95 Norm	UCL95 LogNorm	EPC	BAF Parameters: Insectivore B_0	Insectivore B_1	Insectivore Median UF	Insectivore Tissue Conc (mg/kg dw)	Herbivore B_0	Herbivore B_1	Herbivore Median UF	Herbivore Tissue Conc (mg/kg dw)	Omnivore B_0	Omnivore B_1	Omnivore Median UF	Omnivore Tissue Conc (mg/kg dw)	Max of Mammal Trophic Groups (mg/kg dw)	Max of Mammal Trophic Groups (mg/kg ww)
Background Soils	Arsenic	11/11	6.70	14.00	8.52	8.77	2.35	10.05	10.14	10.14	-4.8471	0.8188	na	0.05	-5.6531	1.1382	na	0.05	-4.5796	0.7354	na	0.06	0.06	0.04
	Barium	3/3	213.00	265.00	234.00	235.00	26.91	280.36	292.98	265.00	na	na	0.0168	4.45	na	na	0.0168	4.45	na	na	0.0168	4.45	4.45	3.03
	Cadmium	1/3	0.25	1.00	0.40	0.50	0.43	1.23	200.13	1.00	0.815	0.9638	na	2.26	-1.2571	0.4723	na	0.28	-1.5383	0.566	na	0.21	2.26	1.54
	Chromium	3/3	20.00	23.00	21.63	21.67	1.53	24.24	24.92	23.00	-1.4599	0.7338	na	2.32	na	na	0.0774	1.78	-1.4599	0.7338	na	2.32	2.32	1.58
	Copper	3/3	15.00	29.00	19.09	20.00	7.81	33.17	78.00	29.00	2.1042	0.1783	na	14.95	na	na	0.0525	1.52	1.4592	0.2681	na	10.61	14.95	10.16
	Lead	11/11	22.00	98.00	36.74	41.91	25.65	55.91	58.67	58.67	0.4819	0.4869	na	11.76	-0.6114	0.5181	na	4.47	0.0761	0.4422	na	6.53	11.76	8.00
	Mercury	1/3	0.05	0.15	0.07	0.08	0.06	0.18	2.92	0.15	na	na	0.0543	0.01	na	na	0.0543	0.01	na	na	0.0543	0.01	0.01	0.01
	Selenium	0/3	2.50	2.50	2.50	2.50	0.00	2.50	2.50	2.50	-0.4158	0.3764	na	0.93	-0.4158	0.3764	na	0.93	-0.4158	0.3764	na	0.93	0.93	0.63
	Silver	0/3	2.50	2.50	2.50	2.50	0.00	2.50	2.50	2.50	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	Zinc	3/3	90.00	127.00	103.14	104.33	19.86	137.81	160.68	127.00	4.4713	0.0738	na	125.06	4.4713	0.0738	na	125.06	4.4713	0.0738	na	125.06	125.06	85.04
Off-Impoundment Soils	Arsenic	69/69	6.00	316.00	13.51	29.93	62.54	42.50	28.24	42.50	-4.8471	0.8188	na	0.17	-5.6531	1.1382	na	0.25	-4.5796	0.7354	na	0.16	0.25	0.17
	Barium	14/14	188.00	413.00	274.29	285.07	84.09	324.85	331.38	331.38	na	na	0.0168	5.57	na	na	0.0168	5.57	na	na	0.0168	5.57	5.57	3.79
	Cadmium	11/14	0.25	43.00	1.25	4.98	11.67	10.50	15.30	15.30	0.815	0.9638	na	31.32	-1.2571	0.4723	na	1.03	-1.5383	0.566	na	1.01	31.32	21.29
	Chromium	14/14	20.00	31.00	22.36	22.57	3.46	24.21	24.12	24.21	-1.4599	0.7338	na	2.41	na	na	0.0774	1.87	-1.4599	0.7338	na	2.41	2.41	1.64
	Copper	14/14	20.00	112.00	33.35	37.79	24.43	49.34	48.74	49.34	2.1042	0.1783	na	16.43	na	na	0.0525	2.59	1.4592	0.2681	na	12.24	16.43	11.18
	Lead	69/69	17.00	6265.00	90.87	523.46	1405.41	806.01	496.03	806.01	0.4819	0.4869	na	42.11	-0.6114	0.5181	na	17.39	0.0761	0.4422	na	20.81	42.11	28.63
	Mercury	4/14	0.05	3.20	0.10	0.49	1.10	1.02	1.32	1.32	na	na	0.0543	0.07	na	na	0.0543	0.07	na	na	0.0543	0.07	0.07	0.05
	Selenium	0/14	2.50	2.50	2.50	2.50	0.00	2.50	2.50	2.50	-0.4158	0.3764	na	0.93	-0.4158	0.3764	na	0.93	-0.4158	0.3764	na	0.93	0.93	0.63
	Silver	0/14	2.50	2.50	2.50	2.50	0.00	2.50	2.50	2.50	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	Zinc	14/14	65.00	1800.00	183.83	319.64	478.99	546.23	550.85	550.85	4.4713	0.0738	na	139.36	4.4713	0.0738	na	139.36	4.4713	0.0738	na	139.36	139.36	94.77
On-Impoundment Soils	Aluminum	11/11	17600.00	26100.00	21834.07	22009.09	2890.83	23586.72	23738.97	23738.97	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	Antimony	1/11	2.50	10.00	2.84	3.18	2.26	4.42	4.04	4.42	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	Arsenic	52/58	2.50	121.00	11.27	18.80	23.81	24.05	23.78	24.05	-4.8471	0.8188	na	0.11	-5.6531	1.1382	na	0.13	-4.5796	0.7354	na	0.11	0.13	0.09
	Barium	13/13	175.00	365.00	236.31	243.23	64.35	275.00	277.01	277.01	na	na	0.0168	4.65	na	na	0.0168	4.65	na	na	0.0168	4.65	4.65	3.16
	Cadmium	9/24	0.25	6.00	0.55	1.11	1.56	1.66	2.03	2.03	0.815	0.9638	na	4.48	-1.2571	0.4723	na	0.40	-1.5383	0.566	na	0.32	4.48	3.04
	Chromium	24/24	16.00	39.00	22.21	22.63	4.83	24.31	24.25	24.31	-1.4599	0.7338	na	2.41	na	na	0.0774	1.88	-1.4599	0.7338	na	2.41	2.41	1.64
	Copper	24/24	13.00	99.00	29.02	33.92	23.08	41.97	41.52	41.97	2.1042	0.1783	na	15.97	na	na	0.0525	2.20	1.4592	0.2681	na	11.72	15.97	10.86
	Lead	58/58	13.00	3239.00	72.21	283.29	600.09	415.67	428.97	428.97	0.4819	0.4869	na	30.98	-0.6114	0.5181	na	12.54	0.0761	0.4422	na	15.74	30.98	21.06
	Mercury	7/24	0.05	1.50	0.09	0.20	0.34	0.32	0.30	0.32	na	na	0.0543	0.02	na	na	0.0543	0.02	na	na	0.0543	0.02	0.02	0.01
	Selenium	0/24	2.50	2.50	2.50	2.50	0.00	2.50	2.50	2.50	-0.4158	0.3764	na	0.93	-0.4158	0.3764	na	0.93	-0.4158	0.3764	na	0.93	0.93	0.63
	Silver	0/24	2.50	2.50	2.50	2.50	0.00	2.50	2.50	2.50	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	Zinc	24/24	47.00	1010.00	131.32	212.50	261.61	303.81	314.05	314.05	4.4713	0.0738	na	133.70	4.4713	0.0738	na	133.70	4.4713	0.0738	na	133.70	133.70	90.92
Site Tailings	Aluminum	40/40	813.00	32700.00	4071.60	7541.35	9038.98	9970.97	11034.40	11034.40	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	Antimony	33/40	2.50	505.00	57.88	130.15	121.20	162.72	626.21	505.00	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	Arsenic	49/49	6.60	637.00	147.60	236.98	149.14	272.78	595.62	595.62	-4.8471	0.8188	na	1.47	-5.6531	1.1382	na	5.05	-4.5796	0.7354	na	1.13	5.05	3.43
	Cadmium	43/46	0.25	250.00	22.34	46.42	46.82	58.02	212.38	212.38	0.815	0.9638	na	395.21	-1.2571	0.4723	na	3.57	-1.5383	0.566	na	4.46	395.21	268.74
	Chromium	39/40	2.50	111.00	18.16	22.66	19.33	27.86	28.03	28.03	-1.4599	0.7338	na	2.68	na	na	0.0774	2.17	-1.4599	0.7338	na	2.68	2.68	1.82
	Copper	48/48	20.00	1323.00	243.01	377.00	321.34	454.92	643.91	643.91	2.1042	0.1783	na	25.98	na	na	0.0525	33.81	1.4592	0.2681	na	24.37	33.81	22.99
	Lead	46/46	19.00	31600.00	2154.97	5468.63	6153.05	6992.76	44489.30	31600.00	0.4819	0.4869	na	251.30	-0.6114	0.5181	na	116.35	0.0761	0.4422	na	105.39	251.30	170.88
	Mercury	40/45	0.05	85.00	1.59	5.51	13.15	8.81	17.06	17.06	na	na	0.0543	0.93	na	na	0.0543	0.93	na	na	0.0543	0.93	0.93	0.63
	Selenium	26/40	0.98	24.00	6.34	8.52	5.97	10.13	12.08	12.08	-0.4158	0.3764	na	1.69	-0.4158	0.3764	na	1.69	-0.4158	0.3764	na	1.69	1.69	1.15
	Silver	38/46	2.50	120.00	19.31	31.17	28.20	38.15	56.45	56.45	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	Zinc	47/47	97.00	33800.00	4046.74	7438.11	6630.33	9062.89	22053.08	22053.08	4.4713	0.0738	na	182.98	4.4713	0.0738	na	182.98	4.4713	0.0738	na	182.98	182.98	124.43

BAF Parameters from ERP. 1998. Development and Validation of Bioaccumulation Models for Small Mammals. ES/ER/TM-219, US Dept of Energy
EPC is equal to the estimated small mammal concentration based on the minimum of the 95UCL and the maximum in soil

Small mammal tissue concentrations were estimated using the equation: ln(conc in small mammals dw)=B_0+B_1(ln[conc in soil dw])
Dry weight concentrations were converted to wet weight using a conversion factor (CF) of 0.68 [EPA, 1993]. ww = dw * CF

APPENDIX C

Estimation of Benthic Invertebrate Tissue Concentrations from Sediment Data

Screening Ecological Risk Assessment for the Richardson Flat Tailings Site

Location	COPC	Detect Freq	Min	Max	Geomean	Mean	Stdev	UCL95 Norm	UCL95 LogNorm	EPC	BSAF 90th Percentile	Benthic Conc (mg/kg dw)	Benthic Conc (mg/kg ww)
Silver Creek - upstream	Aluminum	6/6	3181.00	15220.00	8629.76	9998 17	5081.85	14188.98	22888.16	15220.00	1	15220 00	2283.00
	Antimony	6/6	39.00	889.00	137.80	245 83	323.59	512.69	2412.86	889.00	1	889 00	133.35
	Arsenic	6/7	33.00	1735 00	219.29	459.14	604.93	902.71	6483.72	1735.00	0.69	1197.15	179.57
	Cadmium	7/7	14.00	179.00	42.33	62.29	60.55	106.68	245 02	179.00	41 55	7437.45	1115.62
	Chromium	7/7	12.00	42.00	25.02	27.30	11.20	35.52	45.06	42 00	0.468	19.66	2.95
	Copper	7/7	47.60	2559.00	608.70	966.66	826 84	1572.94	13577.66	2559.00	23.87	61083.33	9162.50
	Lead	7/7	641 00	42990.00	4998.14	11004.43	14850.40	21893.50	301984.65	42990.00	0.607	26094.93	3914.24
	Mercury	6/7	0.10	1 60	0.41	0.57	0.51	0.95	2.24	1.60	2.868	4.59	0.69
	Selenium	4/7	5.00	33.50	15.09	19.07	11.82	27.74	59.57	32.00	1	32.00	4.80
	Silver	7/7	3.33	136.00	31.97	51.19	45.44	84.51	612.49	136.00	1	136.00	20.40
	Zinc	7/7	2330.00	44560.00	8257.95	12930.57	14756.16	23750.54	59831.80	44560.00	7.527	335403.12	50310.47
Silver Creek - downstream	Aluminum	4/4	8943.00	11590 00	10383.47	10438.00	1216 75	11867.68	12026.22	11590.00	1	11590.00	1738.50
	Antimony	4/4	97.00	140.00	122.74	124.00	19.65	147.09	154.10	140.00	1	140.00	21.00
	Arsenic	4/4	177.00	341.00	271.46	280.25	75.53	369.00	432 66	341.00	0.69	235.29	35.29
	Cadmium	4/4	29.00	58.00	42.00	43.50	12.97	58.74	67.71	58.00	41.55	2409.90	361.49
	Chromium	4/4	21.00	32.00	26.91	27.25	4.86	32.96	34.70	32.00	0.468	14.98	2 25
	Copper	4/4	430 00	766.00	584 34	596.50	137.30	757.83	811.65	766.00	23.87	18284 42	2742.66
	Lead	4/4	4861 00	11130.00	6878.41	7223.25	2739.70	10442 39	12553.65	11130.00	0.607	6755.91	1013.39
	Mercury	4/4	0.11	0.44	0.22	0 25	0.14	0.41	0.77	0.44	2.868	1.26	0.19
	Selenium	4/4	5 00	11.00	8.82	9.25	2.87	12.62	16 99	11.00	1	11 00	1.65
	Silver	4/4	28.00	49.00	37.23	38.00	8.83	48.38	51.56	49.00	1	49.00	7.35
	Zinc	4/4	6780.00	11950.00	8964.73	9314.00	2918.16	12742.84	14737.98	11950.00	7.527	89947.65	13492.15
South Diversion Ditch	Aluminum	7/7	4850.00	20600.00	8644.57	9538.57	5188.37	13342.95	15125.44	15125.44	1	15125.44	2268.82
	Antimony	7/7	36.00	97.00	65.32	68.43	21 46	84.17	92.87	92.87	1	92.87	13.93
	Arsenic	7/7	101.00	205.00	129.00	132.71	36.59	159.54	162.87	162.87	0 69	112.38	16.86
	Cadmium	7/7	18.00	73.00	40.19	43.29	17.09	55.81	66.18	66.18	41.55	2749 83	412 48
	Chromium	7/7	16.00	30.00	19.46	19.86	4.71	23.31	23.52	23.52	0.468	11.01	1.65
	Copper	7/7	173.00	280.00	230.34	233 29	38.99	261.87	269.63	269.63	23.87	6436 00	965 40
	Lead	7/7	1880 00	3490.00	2548.27	2590 00	508.07	2962.54	3041 88	3041.88	0.607	1846.42	276.96
	Mercury	7/7	0.32	1 60	0.95	1.05	0.44	1.37	1.89	1.60	2.868	4.59	0.69
	Selenium	3/7	2.50	8.00	3.69	4 14	2.23	5 78	6.98	6.98	1	6.98	1.05
	Silver	7/7	13.00	25 00	17.74	18 14	4.14	21.18	21.94	21.94	1	21.94	3.29
	Zinc	7/7	2940.00	12000.00	7281.82	7811.43	2744.78	9824.04	12099.50	12000.00	7.527	90324.00	13548.60
Wetlands Area	Aluminum	5/5	1930 00	28800.00	9659.25	15072.00	12825.66	27289.27	664196.01	28800 00	1	28800.00	4320.00
	Antimony	5/5	40.10	99.00	79.85	84.04	25.19	108 04	144.44	99.00	1	99.00	14.85
	Arsenic	5/5	128 00	310.00	195.60	203.60	66.08	266 54	299.77	299.77	0 69	206.84	31 03
	Barium	5/5	92 10	562.00	230.36	275.62	180.96	448 00	1022.40	562.00	1	562 00	84.30
	Cadmium	5/5	40.30	93.10	62.74	65.34	20.37	84 75	97.43	93.10	41.55	3868.31	580.25
	Chromium	5/5	14 90	62.40	29.19	35.16	23.12	57.19	130.42	62.40	0 468	29 20	4.38
	Cobalt	5/5	5.80	20 00	12.56	13.78	6.01	19.50	30.28	20.00	5.25	105.00	15.75
	Copper	5/5	183 00	725 00	339 43	396.40	241.64	626 58	1157.22	725.00	23.87	17305.75	2595.86
	Lead	5/5	2350.00	6520 00	4314.48	4662.00	1886.42	6458.93	9405.13	6520.00	0.607	3957.64	593.65
	Manganese	5/5	2200 00	42000.00	5078.18	10938.00	17401.75	27514.29	426571.78	42000.00	1	42000 00	6300.00
	Mercury	5/5	1.30	8.20	3.33	4 10	2.86	6.83	16.85	8.20	2.868	23.52	3.53
	Nickel	5/5	13.20	97.20	35.73	44.90	32.97	76.30	233.95	97.20	2.32	225.50	33.83
	Selenium	5/5	9.90	43.10	15.33	18.18	14.03	31.54	48.52	43.10	1	43.10	6.47
	Silver	5/5	8.00	41.30	17.47	20.90	13.79	34.04	75.56	41.30	1	41.30	6.20
	Thallium	5/5	6.60	13.60	8 27	8.58	2.85	11.30	12.16	12.16	1	12.16	1.82
	Vanadium	5/5	9.50	70.60	29.46	38.34	27 95	64.97	289 48	70.60	1	70 60	10.59
	Zinc	5/5	5400.00	15200.00	9903.53	10532.00	3837.33	14187.31	18484.37	15200.00	7.527	114410.40	17161.56

BJC, 1998. Biota Sediment Accumulation Factors for Invertebrates: Review and Recommendations for the Oak Ridge Reservation. BJC-OR-112. US Dept. of Energy. August 1998.
EPC is equal to the estimated benthic invertebrate concentration based on the minimum of the 95UCL and the maximum in sediment.

Benthic tissue concentrations were estimated using the equation: conc in benthics dw)=BSAF * conc in sediment dw
Dry weight concentrations were converted to wet weight using a conversion factor (CF) of 0.15 [USFWS, 1998] ww = dw * CF

APPENDIX D

DERIVATION OF WILDLIFE TOXICITY REFERENCE VALUES (TRVs)

TRV CALCULATION WORKSHEET FOOTNOTES:

1 If no study is available to establish a LOAEL TRV, the LOAEL is set to equal 3 x NOAEL
2 TRV(food) = TRV(water) / 0.50
3 Test species uncertainty factor equals 1 since both Old World and New World mice are physiologically similar;
and laboratory rodents are often more sensitive than wild species due to genetic heterogeneity of natural populations.
4 TRV(water or capsule) = TRV(food) * 0.50
5 TRV = Study Dose / UF

SMF = Study Modifying Factor
NA = Not Available
UF = Uncertainty Factor
NOAEL = No observed adverse effect level
LOAEL = Lowest observed adverse effect level
BW = body weight
TRV = Toxicity Reference Value

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NOAEL & LOAEL TRVs - ALUMINUM

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	N	Doses	Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/kg BW/day) Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day)[1]	Uncertainty Factors (UF): Inter-species	Duration	Endpoint NOAEL	Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Deer Mice (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				1.13	5.5
Deer Mice (diet)	Golub et al., 1987	Aluminum lactate	Oral Diet	Rat	Chronic			Reproduction, Growth	85	413	0.08 ORNL 1996	6.8	33.04	3	1	1	1	1	3	3	2.27	11.01
Mink (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				0.68	3.3
Mink (diet)	Golub et al., 1987	Aluminum lactate	Oral Diet	Rat	Chronic			Reproduction, Growth	85	413	0.08 ORNL 1996	6.8	33.04	5	1	1	1	1	5	5	1.36	6.61
Masked Shrew (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				0.68	3.3
Masked Shrew (diet)	Golub et al., 1987	Aluminum lactate	Oral Diet	Rat	Chronic			Reproduction, Growth	85	413	0.08 ORNL 1996	6.8	33.04	5	1	1	1	1	5	5	1.36	6.61
Red Fox (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				0.68	3.3
Red Fox (diet)	Golub et al., 1987	Aluminum lactate	Oral Diet	Rat	Chronic			Reproduction, Growth	85	413	0.08 ORNL 1996	6.8	33.04	5	1	1	1	1	5	5	1.36	6.61
American Robin (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				3.50	17.5
American Robin (diet)	Sparling, 1990	Aluminum sulphate	Oral Diet	Mallard	Chronic; 10 weeks			Reproduction, Growth	200.0	1,000	0.175 Camardese et al., 1990	35.00	175.0	5	1	1	1	1	5	5	7.00	35.0
Cliff Swallow (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				3.50	17.5
Cliff Swallow (diet)	Sparling, 1990	Aluminum sulphate	Oral Diet	Mallard	Chronic; 10 weeks			Reproduction, Growth	200.0	1,000	0.175 Camardese et al., 1990	35.00	175.0	5	1	1	1	1	5	5	7.00	35.0
American Kestrel (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				3.50	17.5
American Kestrel (diet)	Sparling, 1990	Aluminum sulphate	Oral Diet	Mallard	Chronic; 10 weeks			Reproduction, Growth	200.0	1,000	0.175 Camardese et al., 1990	35.00	175.0	5	1	1	1	1	5	5	7.00	35.0
Belted Kingfisher (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				3.50	17.5
Belted Kingfisher (diet)	Sparling, 1990	Aluminum sulphate	Oral Diet	Mallard	Chronic; 10 weeks			Reproduction, Growth	200.0	1,000	0.175 Camardese et al., 1990	35.00	175.0	5	1	1	1	1	5	5	7.00	35.0
Mallard Duck (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				3.50	17.5
Mallard Duck (diet)	Sparling, 1990	Aluminum sulphate	Oral Diet	Mallard	Chronic; 10 weeks			Reproduction, Growth	200.0	1,000	0.175 Camardese et al., 1990	35.00	175.0	5	1	1	1	1	5	5	7.00	35.0

NOAEL & LOAEL TRVs - **ALUMINUM**

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	Study Factors: N	Study Factors: Doses	Study Factors: Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day) Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) [3]	Uncertainty Factors (UF): Inter-species	Uncertainty Factors (UF): Duration	Uncertainty Factors (UF): Endpoint NOAEL	Uncertainty Factors (UF): Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Greater-Sage Grouse (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				3.50	17.5
Greater-Sage Grouse (diet)	Sparling, 1990	Aluminum sulphate	Oral Diet	Mallard	Chronic, 10 weeks			Reproduction, Growth	200.0	1,000	0.175 Cannardese et al., 1990	35.00	175.0	5	1	1	1	1	5	5	7.00	35.0

NOAEL & LOAEL TRVs - ANTIMONY

Receptor	Study	Chemical	Route	Study Test Species	Study Factors				NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day)	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) [1]	Uncertainty Factors (UF)					Total UF[5]		NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
					Duration	N	Doses	Endpoint			Source			Inter-species	Duration	Endpoint NOAEL	Endpoint LOAEL	Other	NOAEL	LOAEL		
Deer Mice (water)	Schroeder et al., 1968	Antimony potassium tartate	Oral Water	Mouse	Chronic, > 1 yr		1 dose of 5 ppm	Lifespan; Longevity		5.00	0.0075 EPA 1988	NA	0.04	1	1	1	1	1	1	1	1.3E-02	3.8E-02
Deer Mice (diet)	No Reliable TRV Establishing Studies Found Derive from Water TRV[2]																				2.5E-02	7.5E-02
Mink (water)	Schroeder et al., 1968	Antimony potassium tartate	Oral Water	Mouse	Chronic, > 1 yr		1 dose of 5 ppm	Lifespan, Longevity		5.00	0.0075 EPA 1988	NA	0.04	4	1	1	1	1	4	4	3.1E-03	9.4E-03
Mink (diet)	No Reliable TRV Establishing Studies Found Derive from Water TRV[2]																				6.3E-03	1.9E-02
Masked Shrew (water)	Schroeder et al., 1968	Antimony potassium tartate	Oral Water	Mouse	Chronic, > 1 yr		1 dose of 5 ppm	Lifespan, Longevity		5.00	0.0075 EPA 1988	NA	0.04	4	1	1	1	1	4	4	3.1E-03	9.4E-03
Masked Shrew (diet)	No Reliable TRV Establishing Studies Found Derive from Water TRV[2]																				6.3E-03	1.9E-02
Red Fox (water)	Schroeder et al., 1968	Antimony potassium tartate	Oral Water	Mouse	Chronic, > 1 yr		1 dose of 5 ppm	Lifespan, Longevity		5.00	0.0075 EPA 1988	NA	0.04	1	1	1	1	1	1	1	1.3E-02	3.8E-02
Red Fox (diet)	No Reliable TRV Establishing Studies Found Derive from Water TRV[2]																				2.5E-02	7.5E-02
American Robin (water)	No Reliable TRV Establishing Studies Found																				NA	NA
American Robin (diet)	No Reliable TRV Establishing Studies Found																				NA	NA
Cliff Swallow (water)	No Reliable TRV Establishing Studies Found																				NA	NA
Cliff Swallow (diet)	No Reliable TRV Establishing Studies Found																				NA	NA
American Kestrel (water)	No Reliable TRV Establishing Studies Found																				NA	NA
American Kestrel (diet)	No Reliable TRV Establishing Studies Found																				NA	NA
Belted Kingfisher (water)	No Reliable TRV Establishing Studies Found																				NA	NA
Belted Kingfisher (diet)	No Reliable TRV Establishing Studies Found																				NA	NA
Mallard Duck (water)	No Reliable TRV Establishing Studies Found																				NA	NA
Mallard Duck (diet)	No Reliable TRV Establishing Studies Found																				NA	NA

NOAEL & LOAEL TRVs - ARSENIC

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	Study Factors: N	Study Factors: Doses	Study Factors: Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day) Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) [1]	Uncertainty Factors (UF): Inter-species	Uncertainty Factors (UF): Duration	Uncertainty Factors (UF): Endpoint NOAEL	Uncertainty Factors (UF): Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Deer Mice (water)	Schroeder & Mitchener, 1971	Arsenite salt	Oral Water	Charles River CD Mice[3]	Chronic, 3 generations	10 animals in each generation	1 dose of 5.06 ppm (5 ppm water + 0 06 ppm diet)	Reproduction, Growth, Longevity	5 06		0.25 ORNL 1996	1 27	NA	1	1	1	1	1	1	1	1.3E+00	3.8E+00
Deer Mice (diet)	No Reliable TRV Establishing Studies Found Derive from Water TRV[2]																				2.5E+00	7.6E+00
Mink (water)	Schroeder & Mitchener, 1971	Arsenite salt	Oral Water	Charles River CD Mice[3]	Chronic; 3 generations	10 animals in each generation	1 dose of 5 06 ppm (5 ppm water + 0.06 ppm diet)	Reproduction, Growth, Longevity	5 06		0 25 ORNL 1996	1 27	NA	5	1	1	1	1	5	5	2.5E-01	7.6E-01
Mink (diet)	Byron et al , 1967	Sodium arsenite	Oral Diet	Beagle	2 years	6 animals per dose group	4 doses each of arsenate or arsenite 5, 25, 50, 125 ppm	Growth, Mortality	50		0 024 ORNL 1996	1 2	NA	4	1	1	1	2 Unknown Effect Level	8	8	1.5E-01	4.5E-01
Masked Shrew (water)	Schroeder & Mitchener, 1971	Arsenite salt	Oral Water	Charles River CD Mice[3]	Chronic; 3 generations	10 animals in each generation	1 dose of 5 06 ppm (5 ppm water + 0 06 ppm diet)	Reproduction, Growth, Longevity	5 06		0 25 ORNL 1996	1.27	NA	5	1	1	1	1	5	5	2.5E-01	7.6E-01
Masked Shrew (diet)	Byron et al , 1967	Sodium arsenite	Oral Diet	Beagle	2 years	6 animals per dose group	4 doses each of arsenate or arsenite 5, 25, 50, 125 ppm	Growth, Mortality	50		0 024 ORNL 1996	1 2	NA	5	1	1	1	2 Unknown Effect Level	10	10	1.2E-01	3.6E-01
Red Fox (water)	Schroeder & Mitchener, 1971	Arsenite salt	Oral Water	Charles River CD Mice[3]	Chronic; 3 generations	10 animals in each generation	1 dose of 5.06 ppm (5 ppm water + 0 06 ppm diet)	Reproduction, Growth, Longevity	5 06		0 25 ORNL 1996	1.27	NA	5	1	1	1	1	5	5	2.5E-01	7.6E-01
Red Fox (diet)	Byron et al., 1967	Sodium arsenite	Oral Diet	Beagle	2 years	6 animals per dose group	4 doses each of arsenate or arsenite 5, 25, 50, 125 ppm	Growth, Mortality	50		0 024 ORNL 1996	1 2	NA	3	1	1	1	2 Unknown Effect Level	6	6	2.0E-01	6.0E-01
American Robin (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				4.1E-01	3.5E+00
American Robin (diet)	Stanley et al , 1994	Sodium arsenate	Oral Diet	Mallard	Chronic; 8 weeks	12 pairs (24 ducks) per diet	4 doses of 0, 25, 100, 400 ppm (Mean at 100 & 400 = 93 & 403 ppm)	Reproduction, Growth	93	403	0 175 Camardese et al , 1990	16	71	5	1	2	1	2 SMF	20	10	8.1E-01	7.1E+00
Cliff Swallow (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				4.1E-01	3.5E+00
Cliff Swallow (diet)	Stanley et al., 1994	Sodium arsenate	Oral Diet	Mallard	Chronic; 8 weeks	12 pairs (24 ducks) per diet	4 doses of 0, 25, 100, 400 ppm (Mean at 100 & 400 = 93 & 403 ppm)	Reproduction, Growth	93	403	0 175 Camardese et al , 1990	16	71	5	1	2	1	2 SMF	20	10	8.1E-01	7.1E+00
American Kestrel (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				4.1E-01	3.5E+00
American Kestrel (diet)	Stanley et al , 1994	Sodium arsenate	Oral Diet	Mallard	Chronic; 8 weeks	12 pairs (24 ducks) per diet	4 doses of 0, 25, 100, 400 ppm (Mean at 100 & 400 = 93 & 403 ppm)	Reproduction, Growth	93	403	0 175 Camardese et al , 1990	16	71	5	1	2	1	2 SMF	20	10	8.1E-01	7.1E+00
Belted Kingfisher (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				4.1E-01	3.5E+00

NOAEL & LOAEL TRVs - ARSENIC

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	Study Factors: N	Study Factors: Doses	Study Factors: Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day): Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day)[1]	Uncertainty Factors (UF): Inter-species	Uncertainty Factors (UF): Duration	Uncertainty Factors (UF): Endpoint NOAEL	Uncertainty Factors (UF): Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Belted Kingfisher (diet)	Stanley et al., 1994	Sodium arsenate	**Oral** Diet	Mallard	Chronic; 8 weeks	12 pairs (24 ducks) per diet	**4 doses of 0, 25, 100,** 400 ppm **(Mean at 100 & 400 =** 93 & 403 ppm)	Reproduction, Growth	93	403	0.175 Camardese et al., 1990	16	71	5	1	2	1	2 SMF	20	10	**8.1E-01**	7.1E+00
Mallard Duck (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				4.1E-01	3.5E+00
Mallard Duck (diet)	Stanley et al., 1994	Sodium arsenate	**Oral** Diet	Mallard	Chronic; 8 weeks	12 pairs (24 ducks) per diet	**4 doses of 0, 25, 100,** 400 ppm **(Mean at 100 & 400 =** 93 & 403 ppm)	Reproduction, Growth	93	403	0.175 Camardese et al., 1990	16	71	5	1	2	1	2 SMF	20	10	**8.1E-01**	7.1E+00
Greater-Sage Grouse (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				4.1E-01	3.5E+00
Greater-Sage Grouse (diet)	Stanley et al., 1994	Sodium arsenate	**Oral** Diet	Mallard	Chronic; 8 weeks	12 pairs (24 ducks) per diet	**4 doses of 0, 25, 100,** 400 ppm **(Mean at 100 & 400 =** 93 & 403 ppm)	Reproduction, Growth	93	403	0.175 Camardese et al., 1990	16	71	5	1	2	1	2 SMF	20	10	**8.1E-01**	7.1E+00

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NOAEL & LOAEL TRVs - BARIUM

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	Study Factors: N	Study Factors: Doses	Study Factors: Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day): Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) [1]	Uncertainty Factors (UF): Inter-species	Uncertainty Factors (UF): Duration	Uncertainty Factors (UF): Endpoint NOAEL	Uncertainty Factors (UF): Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Deer Mice (water)	Perry et al 1983	Barium chloride	Oral Water	Rat	16 months		3 exposures 1, 10, 100 ppm	Growth; Hypertension	100.00		0.05 Measured in study	5.06	NA	3	1	1	1	1	3	3	1.7E+00	5.1E+00
Deer Mice (diet)	No Reliable TRV Establishing Study Derive from water TRV																				3.4E+00	1.0E+01
Mink (water)	Perry et al 1983	Barium chloride	Oral Water	Rat	16 months		3 exposures 1, 10, 100 ppm	Growth; Hypertension	100.00		0.05 Measured in study	5.06	NA	5	1	1	1	1	5	5	1.0E+00	3.0E+00
Mink (diet)	No Reliable TRV Establishing Study Derive from water TRV																				2.0E+00	6.1E+00
Masked Shrew (water)	Perry et al 1983	Barium chloride	Oral Water	Rat	16 months		3 exposures 1, 10, 100 ppm	Growth; Hypertension	100.00		0.05 Measured in study	5.06	NA	5	1	1	1	1	5	5	1.0E+00	3.0E+00
Masked Shrew (diet)	No Reliable TRV Establishing Study Derive from water TRV																				2.0E+00	6.1E+00
Red Fox (water)	Perry et al 1983	Barium chloride	Oral Water	Rat	16 months		3 exposures 1, 10, 100 ppm	Growth; Hypertension	100.00		0.05 Measured in study	5.06	NA	5	1	1	1	1	5	5	1.0E+00	3.0E+00
Red Fox (diet)	No Reliable TRV Establishing Study Derive from water TRV																				2.0E+00	6.1E+00
American Robin (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.4E+00	2.8E+00
American Robin (diet)	Johnson et al 1960		Oral Diet	Chicken	4 weeks Subchronic duration		8 exposures 250, 500, 1000, 2000, 4000, 8000, 16,000, 32,000 ppm	Mortality	2,000	4,000	0.104 BW & FCNS - EPA 1988a	208	417	5	5 Subchronic	3 Endpoint = Lethality	3	1	75	75	2.8E+00	5.6E+00
Cliff Swallow (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.4E+00	2.8E+00
Cliff Swallow (diet)	Johnson et al 1960		Oral Diet	Chicken	4 weeks Subchronic duration		8 exposures 250, 500, 1000, 2000, 4000, 8000, 16,000, 32,000 ppm	Mortality	2,000	4,000	0.104 BW & FCNS - EPA 1988a	208	417	5	5 Subchronic	3 Endpoint = Lethality	3	1	75	75	2.8E+00	5.6E+00
American Kestrel (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.4E+00	2.8E+00
American Kestrel (diet)	Johnson et al 1960		Oral Diet	Chicken	4 weeks Subchronic duration		8 exposures 250, 500, 1000, 2000, 4000, 8000, 16,000, 32,000 ppm	Mortality	2,000	4,000	0.104 BW & FCNS - EPA 1988a	208	417	5	5 Subchronic	3 Endpoint = Lethality	3	1	75	75	2.8E+00	5.6E+00
Belted Kingfisher (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.4E+00	2.8E+00
Belted Kingfisher (diet)	Johnson et al 1960		Oral Diet	Chicken	4 weeks Subchronic duration		8 exposures 250, 500, 1000, 2000, 4000, 8000, 16,000, 32,000 ppm	Mortality	2,000	4,000	0.104 BW & FCNS - EPA 1988a	208	417	5	5 Subchronic	3 Endpoint = Lethality	3	1	75	75	2.8E+00	5.6E+00
Mallard Duck (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.4E+00	2.8E+00
Mallard Duck (diet)	Johnson et al 1960		Oral Diet	Chicken	4 weeks Subchronic duration		8 exposures 250, 500, 1000, 2000, 4000, 8000, 16,000, 32,000 ppm	Mortality	2,000	4,000	0.104 BW & FCNS - EPA 1988a	208	417	5	5 Subchronic	3 Endpoint = Lethality	3	1	75	75	2.8E+00	5.6E+00
Greater-Sage Grouse (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.4E+00	2.8E+00

***NOAEL & LOAEL TRVs* - BARIUM**

					Study Factors						Conversion Factor (kg food/ kg BW/day)			Uncertainty Factors (UF)								
Receptor	Study	Chemical	Route	Study Test Species	Duration	N	Doses	Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day)[1]	Inter-species	Duration	Endpoint NOAEL	Endpoint LOAEL	Other	Total UF[3] NOAEL	Total UF[3] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Greater-Sage Grouse (diet)	Johnson et al 1960		Oral	Chicken	4 weeks		8 exposures	Mortality	2,000	4,000	0.104	208	417	5	5	3	3	1	75	75	2.8E+00	5.6E+00
			Diet		Subchronic duration		250, 500, 1000, 2000, 4000, 8000, 16,000, 32,000 ppm				BW & FCNS - EPA 1988a				Subchronic	Endpoint = Lethality						

NOAEL & LOAEL TRVs - **CADMIUM**

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	Study Factors: N	Study Factors: Doses	Study Factors: Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day): Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day)[1]	Uncertainty Factors (UF): Inter-species	Uncertainty Factors (UF): Duration	Uncertainty Factors (UF): Endpoint NOAEL	Uncertainty Factors (UF): Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Deer Mice (water)	Schroeder & Mitchener, 1971	**Soluble cadmium** salts	Oral Water	Charles River CD Mice	Chronic, 3 generations	10 animals per dose group	1 expsoure of 10 mg/L (0.1 ppm in diet)	Reproduction		10	0.25 ORNL 1996	NA	2.5	1	1	1	1	1	1	1	**0.83**	**2.5**
Deer Mice (diet)	Wilson et al., 1941	Cadmium chloride	Oral Diet	Albino rats	Chronic; 100 days	4 to 6 animals per dose group	6 exposures (0 control, 31, 62, 125, 250, 500 ppm)	Growth	31	62	0.08 ORNL 1996	2.48	4.96	3	1	1	1	1	3	3	**0.83**	**1.7**
Mink (water)	Schroeder & Mitchener, 1971	**Soluble cadmium** salts	Oral Water	Charles River CD Mice	Chronic, 3 generations	10 animals per dose group	1 expsoure of 10 mg/L (0.1 ppm in diet)	Reproduction		10	0.25 ORNL 1996	NA	2.5	5	1	1	1	1	5	5	**0.17**	**0.5**
Mink (diet)	Wilson et al., 1941	Cadmium chloride	Oral Diet	Albino rats	Chronic; 100 days	4 to 6 animals per dose group	6 exposures (0 control, 31, 62, 125, 250, 500 ppm)	Growth	31	62	0.08 ORNL 1996	2.48	4.96	5	1	1	1	1	5	5	0.50	1.0
Masked Shrew (water)	Schroeder & Mitchener, 1971	**Soluble cadmium** salts	Oral Water	Charles River CD Mice	Chronic, 3 generations	10 animals per dose group	1 expsoure of 10 mg/L (0.1 ppm in diet)	Reproduction		10	0.25 ORNL 1996	NA	2.5	5	1	1	1	1	5	5	**0.17**	**0.5**
Masked Shrew (diet)	Wilson et al., 1941	Cadmium chloride	Oral Diet	Albino rats	Chronic; 100 days	4 to 6 animals per dose group	6 exposures (0 control, 31, 62, 125, 250, 500 ppm)	Growth	31	62	0.08 ORNL 1996	2.48	4.96	5	1	1	1	1	5	5	0.50	1.0
Red Fox (water)	Schroeder & Mitchener, 1971	**Soluble cadmium** salts	Oral Water	Charles River CD Mice	Chronic; 3 generations	10 animals per dose group	1 expsoure of 10 mg/L (0.1 ppm in diet)	Reproduction		10	0.25 ORNL 1996	NA	2.5	5	1	1	1	1	5	5	**0.17**	**0.5**
Red Fox (diet)	Wilson et al., 1941	Cadmium chloride	Oral Diet	Albino rats	Chronic, 100 days	4 to 6 animals per dose group	6 exposures (0 control, 31, 62, 125, 250, 500 ppm)	Growth	31	62	0.08 ORNL 1996	2.48	4.96	5	1	1	1	1	5	5	0.50	1.0
American Robin (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				0.04	1.2
American Robin (diet)	White & Finley, 1978	Cadmium chloride	Oral Diet	Mallard	Chronic; 90 days	20 animals per dose group	4 exposure groups (0 control, 20, 200, 2000 ppm wet weight)	Reproduction	17.3	239	0.1 Measured in study	1.73	23.9	5	1	2	1	2 SMF	20	10	0.09	2.4
Cliff Swallow (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				0.04	1.2
Cliff Swallow (diet)	White & Finley, 1978	Cadmium chloride	Oral Diet	Mallard	Chronic, 90 days	20 animals per dose group	4 exposure groups (0 control, 20, 200, 2000 ppm wet weight)	Reproduction	17.3	239	0.1 Measured in study	1.73	23.9	5	1	2	1	2 SMF	20	10	0.09	2.4
American Kestrel (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				0.04	1.2
American Kestrel (diet)	White & Finley, 1978	Cadmium chloride	Oral Diet	Mallard	Chronic; 90 days	20 animals per dose group	4 exposure groups (0 control, 20, 200, 2000 ppm wet weight)	Reproduction	17.3	239	0.1 Measured in study	1.73	23.9	5	1	2	1	2 SMF	20	10	0.09	2.4
Belted Kingfisher (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				0.04	1.2
Belted Kingfisher (diet)	White & Finley, 1978	Cadmium chloride	Oral Diet	Mallard	Chronic; 90 days	20 animals per dose group	4 exposure groups (0 control, 20, 200, 2000 ppm wet weight)	Reproduction	17.3	239	0.1 Measured in study	1.73	23.9	5	1	2	1	2 SMF	20	10	0.09	2.4

NOAEL & LOAEL TRVs - CADMIUM

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	Study Factors: N	Study Factors: Doses	Study Factors: Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day): Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) [1]	Uncertainty Factors (UF): Inter-species	Uncertainty Factors (UF): Duration	Uncertainty Factors (UF): Endpoint NOAEL	Uncertainty Factors (UF): Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Mallard Duck (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				0.04	1.2
Mallard Duck (diet)	White & Finley, 1978	Cadmium chloride	Oral Diet	Mallard	Chronic; 90 days	20 animals per dose group	4 exposure groups (0 control, 20, 200, 2000 ppm wet weight)	Reproduction	17 3	239	0 1 Measured in study	1 73	23 9	5	1	2	1	2 SMF	20	10	0.09	2.4
Greater-Sage Grouse (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				0.04	1.2
Greater-Sage Grouse (diet)	White & Finley, 1978	Cadmium chloride	Oral Diet	Mallard	Chronic; 90 days	20 animals per dose group	4 exposure groups (0 control, 20, 200, 2000 ppm wet weight)	Reproduction	17.3	239	0 1 Measured in study	1 73	23.9	5	1	2	1	2 SMF	20	10	0.09	2.4

NOAEL & LOAEL TRVs - CHROMIUM

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	N	Doses	Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day): Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) [1]	Uncertainty Factors (UF): Inter-species	Duration	Endpoint NOAEL	Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Deer Mice (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				6.7E+02	2.0E+03
Deer Mice (diet)	Ivankovic and Preussmann 1975	Chromium oxide Cr^{+3}	Oral Diet	Rat	90 days & 2 years Chronic		3 exposures 1%, 2%, 5%	Reproduction, Longevity	50000		0.08 BW & FCNS - EPA 1988a	4000	NA	3	1	1	1	1	3	3	1.3E+03	4.0E+03
Mink (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				4.0E+02	1.2E+03
Mink (diet)	Ivankovic and Preussmann 1975	Chromium oxide Cr^{+3}	Oral Diet	Rat	90 days & 2 years Chronic		3 exposures 1%, 2%, 5%	Reproduction; Longevity	50000		0.08 BW & FCNS - EPA 1988a	4000	NA	5	1	1	1	1	5	5	8.0E+02	2.4E+03
Masked Shrew (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				4.0E+02	1.2E+03
Masked Shrew (diet)	Ivankovic and Preussmann 1975	Chromium oxide Cr^{+3}	Oral Diet	Rat	90 days & 2 years Chronic		3 exposures 1%, 2%, 5%	Reproduction, Longevity	50000		0.08 BW & FCNS - EPA 1988a	4000	NA	5	1	1	1	1	5	5	8.0E+02	2.4E+03
Red Fox (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				4.0E+02	1.2E+03
Red Fox (diet)	Ivankovic and Preussmann 1975	Chromium oxide Cr^{+3}	Oral Diet	Rat	90 days & 2 years Chronic		3 exposures 1%, 2%, 5%	Reproduction, Longevity	50000		0.08 BW & FCNS - EPA 1988a	4000	NA	5	1	1	1	1	5	5	8.0E+02	2.4E+03
American Robin (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.0E-01	5.0E-01
American Robin (diet)	Haseltine et al 1985	Chromium potassium sulfate Cr^{+3}	Oral Diet	Black duck	10 months Critical lifestage		2 exposures 10 & 50 ppm	Reproduction	10	50	0.1 BW - Dunning 1984, FCNS - Heinz et al 1989	1.0	5.0	5	1	1	1	1	5	5	2.0E-01	1.0E+00
Cliff Swallow (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.0E-01	5.0E-01
Cliff Swallow (diet)	Haseltine et al 1985	Chromium potassium sulfate Cr^{+3}	Oral Diet	Black duck	10 months Critical lifestage		2 exposures 10 & 50 ppm	Reproduction	10	50	0.1 BW - Dunning 1984, FCNS - Heinz et al 1989	1.0	5.0	5	1	1	1	1	5	5	2.0E-01	1.0E+00
American Kestrel (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.0E-01	5.0E-01
American Kestrel (diet)	Haseltine et al 1985	Chromium potassium sulfate Cr^{+3}	Oral Diet	Black duck	10 months Critical lifestage		2 exposures 10 & 50 ppm	Reproduction	10	50	0.1 BW - Dunning 1984, FCNS - Heinz et al 1989	1.0	5.0	5	1	1	1	1	5	5	2.0E-01	1.0E+00
Belted Kingfisher (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.0E-01	5.0E-01
Belted Kingfisher (diet)	Haseltine et al 1985	Chromium potassium sulfate Cr^{+3}	Oral Diet	Black duck	10 months Critical lifestage		2 exposures 10 & 50 ppm	Reproduction	10	50	0.1 BW - Dunning 1984, FCNS - Heinz et al 1989	1.0	5.0	5	1	1	1	1	5	5	2.0E-01	1.0E+00
Mallard Duck (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.0E-01	5.0E-01

NOAEL & LOAEL TRVs - CHROMIUM

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	N	Doses	Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day): Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day)[1]	Uncertainty Factors (UF): Inter-species	Duration	Endpoint: NOAEL	Endpoint: LOAEL	Other	Total UF[5]: NOAEL	Total UF[5]: LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Mallard Duck (diet)	Haseltine et al 1985	Chromium potassium sulfate Cr^{+3}	Oral Diet	Black duck	10 months Critical lifestage		2 exposures 10 & 50 ppm	Reproduction	10	50	0.1 BW - Dunning 1984, FCNS - Heinz et al 1989	1.0	5.0	5	1	1	1	1	5	5	2.0E-01	1.0E+00
Greater-Sage Grouse (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.0E-01	5.0E-01
Greater-Sage Grouse (diet)	Haseltine et al 1985	Chromium potassium sulfate Cr^{+3}	Oral Diet	Black duck	10 months Critical lifestage		2 exposures 10 & 50 ppm	Reproduction	10	50	0.1 BW - Dunning 1984; FCNS - Heinz et al 1989	1.0	5.0	5	1	1	1	1	5	5	2.0E-01	1.0E+00

NOAEL & LOAEL TRVs - COBALT

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	Study Factors: N	Study Factors: Doses	Study Factors: Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day): Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) [1]	Uncertainty Factors (UF): Inter-species	Uncertainty Factors (UF): Duration	Uncertainty Factors (UF): Endpoint NOAEL	Uncertainty Factors (UF): Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Deer Mice (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.1E+00	3.3E+00
Deer Mice (diet)	Mollenhauer et al 1985	Cobalt chloride	Oral Diet	Rat	98 days			Reproduction Testicular degeneration			1 None required	NA	20	3	1	1	1	1	3	3	2.2E+00	6.7E+00
Mink (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				6.7E-01	2.0E+00
Mink (diet)	Mollenhauer et al 1985	Cobalt chloride	Oral Diet	Rat	98 days			Reproduction Testicular degeneration			1 None required	NA	20	5	1	1	1	1	5	5	1.3E+00	4.0E+00
Masked Shrew (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				6.7E-01	2.0E+00
Masked Shrew (diet)	Mollenhauer et al 1985	Cobalt chloride	Oral Diet	Rat	98 days			Reproduction Testicular degeneration			1 None required	NA	20	5	1	1	1	1	5	5	1.3E+00	4.0E+00
Red Fox (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				6.7E-01	2.0E+00
Red Fox (diet)	Mollenhauer et al 1985	Cobalt chloride	Oral Diet	Rat	98 days			Reproduction Testicular degeneration			1 None required	NA	20	5	1	1	1	1	5	5	1.3E+00	4.0E+00
American Robin (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				1.3E-01	2.7E-01
American Robin (diet)	Hill 1974	Cobalt chloride hexahydrate	Oral Diet	Chicken	2 weeks	10 chicks per dose group	5 exposures + control (0/50/100/200/300/400 mg/kg)	Growth, Mortality	50	100	0.11 From EcoSSL derivation	1.3 *Adjusted to account for 25% Co in $CoCl_2 6H_2O$	2.7	5	1	1	1	1	5	5	2.7E-01	5.3E-01
Cliff Swallow (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				1.3E-01	2.7E-01
Cliff Swallow (diet)	Hill 1974	Cobalt chloride hexahydrate	Oral Diet	Chicken	2 weeks	10 chicks per dose group	5 exposures + control (0/50/100/200/300/400 mg/kg)	Growth, Mortality	50	100	0.11 From EcoSSL derivation	1.3 *Adjusted to account for 25% Co in $CoCl_2 6H_2O$	2.7	5	1	1	1	1	5	5	2.7E-01	5.3E-01
American Kestrel (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				1.3E-01	2.7E-01
American Kestrel (diet)	Hill 1974	Cobalt chloride hexahydrate	Oral Diet	Chicken	2 weeks	10 chicks per dose group	5 exposures + control (0/50/100/200/300/400 mg/kg)	Growth, Mortality	50	100	0.11 From EcoSSL derivation	1.3 *Adjusted to account for 25% Co in $CoCl_2 6H_2O$	2.7	5	1	1	1	1	5	5	2.7E-01	5.3E-01
Belted Kingfisher (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				1.3E-01	2.7E-01
Belted Kingfisher (diet)	Hill 1974	Cobalt chloride hexahydrate	Oral Diet	Chicken	2 weeks	10 chicks per dose group	5 exposures + control (0/50/100/200/300/400 mg/kg)	Growth, Mortality	50	100	0.11 From EcoSSL derivation	1.3 *Adjusted to account for 25% Co in $CoCl_2 6H_2O$	2.7	5	1	1	1	1	5	5	2.7E-01	5.3E-01
Mallard Duck (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				1.3E-01	2.7E-01
Mallard Duck (diet)	Hill 1974	Cobalt chloride hexahydrate	Oral Diet	Chicken	2 weeks	10 chicks per dose group	5 exposures + control (0/50/100/200/300/400 mg/kg)	Growth, Mortality	50	100	0.11 From EcoSSL derivation	1.3 *Adjusted to account for 25% Co in $CoCl_2 6H_2O$	2.7	5	1	1	1	1	5	5	2.7E-01	5.3E-01
Greater-Sage Grouse (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				1.3E-01	2.7E-01

***NOAEL & LOAEL TRVs* - COBALT**

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	Study Factors: N	Study Factors: Doses	Study Factors: Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day): Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) [1]	Uncertainty Factors (UF): Inter-species	Uncertainty Factors (UF): Duration	Uncertainty Factors (UF): Endpoint NOAEL	Uncertainty Factors (UF): Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Greater-Sage Grouse (diet)	Hill 1974	Cobalt chloride hexahydrate	Oral Diet	Chicken	2 weeks	10 chicks per dose group	5 exposures + control (0/50/100/200/300/400 mg/kg)	Growth, Mortality	50	100	0.11 From EcoSSL derivation	1.3 *Adjusted to account for 25% Co in $CoCl_2 \cdot 6H_2O$	2.7	5	1	1	1	1	5	5	2.7E-01	5.3E-01

NOAEL & LOAEL TRVs - **COPPER**

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	Study Factors: N	Study Factors: Doses	Study Factors: Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day) Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) [1]	Uncertainty Factors (UF): Inter-species	Uncertainty Factors (UF): Duration	Uncertainty Factors (UF): Endpoint NOAEL	Uncertainty Factors (UF): Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Deer Mice (water)	Hebert et al., 1993	Copper sulfate	Oral Water	B6C3F1 mice	Subchronic, 15 days	5 animals per sex per dose group	5 exposures (0, 300, 1000, 3000, 10000 mg/L)	Growth, Mortality			1 None Required	95	226	1	5	5	5	1	25	25	3.8E+00	9.0E+00
Deer Mice (diet)	Hebert et al., 1993	Copper sulfate	Oral Diet	B6C3F1 mice	Chronic, 92 days	10 animals per sex per dose group	6 exposures (0, 1000, 2000, 4000, 8000, 16000 mg/kg)	Reproduction, Growth			1 None Required	168	362	1	1	1	1	1	1	1	1.7E+02	3.6E+02
Mink (water)	Aulerich et al., 1982	Copper sulfate	Oral Water	Mink	Chronic, 357 days	24 animals per dose group	5 exposures (60.5 control, 25, 50, 100, 200 mg/kg)	Reproduction (Reproductive success)	110.5	160.5	0.16 USEPA, 1993	17.7	25.7	1	1	1	1	1	1	1	1.8E+01	2.6E+01
Mink (diet)	**No Reliable TRV Establishing Studies Found** Derive from Water TRV[2]																				8.8E+00	1.3E+01
Masked Shrew (water)	Hebert et al., 1993	Copper sulfate	Oral Water	B6C3F1 mice	Subchronic, 15 days	5 animals per sex per dose group	5 exposures (0, 300, 1000, 3000, 10000 mg/L)	Growth, Mortality			1 None Required	95	226	5	5	5	5	1	125	125	7.6E-01	1.8E+00
Masked Shrew (diet)	Hebert et al., 1993	Copper sulfate	Oral Diet	B6C3F1 mice	Chronic, 92 days	10 animals per sex per dose group	6 exposures (0, 1000, 2000, 4000, 8000, 16000 mg/kg)	Reproduction, Growth			1 None Required	168	362	5	1	1	1	1	5	5	3.4E+01	7.2E+01
Red Fox (water)	Aulerich et al., 1982	Copper sulfate	Oral Water	Mink	Chronic, 357 days	24 animals per dose group	5 exposures (60.5 control, 25, 50, 100, 200 mg/kg)	Reproduction (Reproductive success)	110.5	160.5	0.16 USEPA, 1993	17.7	25.7	4	1	1	1	1	4	4	4.4E+00	6.4E+00
Red Fox (diet)	**No Reliable TRV Establishing Studies Found** Derive from Water TRV[2]																				2.2E+00	3.2E+00
American Robin (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				2.0E+00	3.0E+00
American Robin (diet)	Jackson & Stevenson, 1981	Copper oxide	Oral Diet	Chicken	Chronic, 40 weeks	22 animals per dose group	6 exposures (0 control, 150, 300, 450, 600, 750 ppm)	Reproduction	300	450	0.067 Measured in study	20.1	30.2	5	1	1	1	1	5	5	4.0E+00	6.0E+00
Cliff Swallow (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				2.0E+00	3.0E+00
Cliff Swallow (diet)	Jackson & Stevenson, 1981	Copper oxide	Oral Diet	Chicken	Chronic, 40 weeks	22 animals per dose group	6 exposures (0 control, 150, 300, 450, 600, 750 ppm)	Reproduction	300	450	0.067 Measured in study	20.1	30.2	5	1	1	1	1	5	5	4.0E+00	6.0E+00
American Kestrel (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				2.0E+00	3.0E+00
American Kestrel (diet)	Jackson & Stevenson, 1981	Copper oxide	Oral Diet	Chicken	Chronic, 40 weeks	22 animals per dose group	6 exposures (0 control, 150, 300, 450, 600, 750 ppm)	Reproduction	300	450	0.067 Measured in study	20.1	30.2	5	1	1	1	1	5	5	4.0E+00	6.0E+00
Belted Kingfisher (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				2.0E+00	3.0E+00
Belted Kingfisher (diet)	Jackson & Stevenson, 1981	Copper oxide	Oral Diet	Chicken	Chronic, 40 weeks	22 animals per dose group	6 exposures (0 control, 150, 300, 450, 600, 750 ppm)	Reproduction	300	450	0.067 Measured in study	20.1	30.2	5	1	1	1	1	5	5	4.0E+00	6.0E+00
Mallard Duck (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				2.0E+00	3.0E+00
Mallard Duck (diet)	Jackson & Stevenson, 1981	Copper oxide	Oral Diet	Chicken	Chronic, 40 weeks	22 animals per dose group	6 exposures (0 control, 150, 300, 450, 600, 750 ppm)	Reproduction	300	450	0.067 Measured in study	20.1	30.2	5	1	1	1	1	5	5	4.0E+00	6.0E+00

***NOAEL & LOAEL TRVs* - COPPER**

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	Study Factors: N	Study Factors: Doses	Study Factors: Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day): Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day)[1]	Uncertainty Factors (UF): Inter-species	Uncertainty Factors (UF): Duration	Uncertainty Factors (UF): Endpoint NOAEL	Uncertainty Factors (UF): Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Greater-Sage Grouse (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				2.0E+00	3.0E+00
Greater-Sage Grouse (diet)	Jackson & Stevenson, 1981	Copper oxide	Oral Diet	Chicken	Chronic, 40 weeks	22 animals per dose group	6 exposures (0 control, 150, 300, 450, 600, 750 ppm)	Reproduction	300	450	0.067 Measured in study	20.1	30.2	5	1	1	1	1	5	5	4.0E+00	6.0E+00

NOAEL & LOAEL TRVs - **LEAD**

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	Study Factors: N	Study Factors: Doses	Study Factors: Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day) Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day)[1]	Uncertainty Factors (UF): Inter-species	Uncertainty Factors (UF): Duration	Uncertainty Factors (UF): Endpoint NOAEL	Uncertainty Factors (UF): Endpoint LOAEL	Other	Total UF[3] NOAEL	Total UF[3] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Deer Mice (water)	Schroeder & Mitchener, 1971	Soluble lead salt	Oral Water	Charles River CD Mice	Chronic, 3 generations	10 animals per dose group	1 exposure (25 mg/L + 0.2 ppm in diet)	Reproduction		25	0.25 Sax & Lewis, 1989	NA	6.25	1	1	1	1	10 Effects seen in utero	10	10	2.1E-01	6.3E-01
Deer Mice (diet)	**No Reliable TRV Establishing Studies Found** Derive from Water TRV[2]																				4.2E-01	1.3E+00
Mink (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				1.6E-01	3.1E-01
Mink (diet)	Horwitt & Cowgill, 1938	Lead acetate	Oral Diet	Dogs	Chronic, prenatal + 7 months	2 to 4 animals per dose group	4 exposures (2 control, 25, 50, 100 ppm)	Reproduction, Growth	52	102	0.024 ORNL, 1996	1.25	2.45	4	1	1	1	1	4	4	3.1E-01	6.1E-01
Masked Shrew (water)	Schroeder & Mitchener, 1971	Soluble lead salt	Oral Water	Charles River CD Mice	Chronic, 3 generations	10 animals per dose group	1 exposure (25 mg/L + 0.2 ppm in diet)	Reproduction		25	0.25 Sax & Lewis, 1989	NA	6.25	5	1	1	1	10 Effects seen in utero	50	50	4.2E-02	1.3E-01
Masked Shrew (diet)	**No Reliable TRV Establishing Studies Found** Derive from Water TRV[2]																				8.3E-02	2.5E-01
Red Fox (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				2.1E-01	4.1E-01
Red Fox (diet)	Horwitt & Cowgill, 1938	Lead acetate	Oral Diet	Dogs	Chronic, prenatal + 7 months	2 to 4 animals per dose group	4 exposures (2 control, 25, 50, 100 ppm)	Reproduction, Growth	52	102	0.024 ORNL, 1996	1.25	2.45	3	1	1	1	1	3	3	4.2E-01	8.2E-01
American Robin (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				4.4E-01	8.8E-01
American Robin (diet)	Edens & Garlich, 1983	Lead acetate	Oral Diet	Leghorn hens	Chronic, 10 weeks (during reproduction)	20 or 40 animals per dose group	3 or 5 exposures Exp 1 - 0, 25, 50 ppm Exp 2 - 0, 50, 100, 200, 400 ppm	Reproduction (Egg production)	25	50	0.175 Sax & Lewis, 1989	4.38	8.75	5	1	1	1	1	5	5	8.8E-01	1.8E+00
Cliff Swallow (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				4.4E-01	8.8E-01
Cliff Swallow (diet)	Edens & Garlich, 1983	Lead acetate	Oral Diet	Leghorn hens	Chronic, 10 weeks (during reproduction)	20 or 40 animals per dose group	3 or 5 exposures Exp 1 - 0, 25, 50 ppm Exp 2 - 0, 50, 100, 200, 400 ppm	Reproduction (Egg production)	25	50	0.175 Sax & Lewis, 1989	4.38	8.75	5	1	1	1	1	5	5	8.8E-01	1.8E+00
American Kestrel (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				4.4E-01	8.8E-01
American Kestrel (diet)	Edens & Garlich, 1983	Lead acetate	Oral Diet	Leghorn hens	Chronic, 10 weeks (during reproduction)	20 or 40 animals per dose group	3 or 5 exposures Exp 1 - 0, 25, 50 ppm Exp 2 - 0, 50, 100, 200, 400 ppm	Reproduction (Egg production)	25	50	0.175 Sax & Lewis, 1989	4.38	8.75	5	1	1	1	1	5	5	8.8E-01	1.8E+00
Belted Kingfisher (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				4.4E-01	8.8E-01
Belted Kingfisher (diet)	Edens & Garlich, 1983	Lead acetate	Oral Diet	Leghorn hens	Chronic, 10 weeks (during reproduction)	20 or 40 animals per dose group	3 or 5 exposures Exp 1 - 0, 25, 50 ppm Exp 2 - 0, 50, 100, 200, 400 ppm	Reproduction (Egg production)	25	50	0.175 Sax & Lewis, 1989	4.38	8.75	5	1	1	1	1	5	5	8.8E-01	1.8E+00

NOAEL & LOAEL TRVs - LEAD

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	Study Factors: N	Study Factors: Doses	Study Factors: Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day): Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) [1]	Uncertainty Factors (UF): Inter-species	Uncertainty Factors (UF): Duration	Uncertainty Factors (UF): Endpoint NOAEL	Uncertainty Factors (UF): Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Mallard Duck (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				4.4E-01	8.8E-01
Mallard Duck (diet)	Edens & Garlich, 1983	Lead acetate	Oral Diet	Leghorn hens	Chronic, 10 weeks (during reproduction)	20 or 40 animals per dose group	3 or 5 exposures **Exp 1- 0, 25, 50 ppm** Exp 2 - 0, 50, 100, 200, 400 ppm	Reproduction (Egg production)	25	50	0.175 Sax & Lewis, 1989	4.38	8.75	5	1	1	1	1	5	5	8.8E-01	1.8E+00
Greater-Sage Grouse (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				4.4E-01	8.8E-01
Greater-Sage Grouse (diet)	Edens & Garlich, 1983	Lead acetate	Oral Diet	Leghorn hens	Chronic, 10 weeks (during reproduction)	20 or 40 animals per dose group	3 or 5 exposures **Exp 1- 0, 25, 50 ppm** Exp 2 - 0, 50, 100, 200, 400 ppm	Reproduction (Egg production)	25	50	0.175 Sax & Lewis, 1989	4.38	8.75	5	1	1	1	1	5	5	8.8E-01	1.8E+00

NOAEL & LOAEL TRVs - NICKEL

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	Study Factors: N	Study Factors: Doses	Study Factors: Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day): Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) [1]	Uncertainty Factors (UF): Inter-species	Uncertainty Factors (UF): Duration	Uncertainty Factors (UF): Endpoint NOAEL	Uncertainty Factors (UF): Endpoint LOAEL	Uncertainty Factors (UF): Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Deer Mice (water)	Smith et al , 1993	Nickel chloride	Oral Water	Long-Evans rats	Chronic, 4 month (11 wks pre-gestation)	34 females per dose grp	4 exposures (control, XX, XX, XX ppm)	Reproduction		1 3	1 None Required	NA	1.30	3	1	1	1	1	3	3	1.4E-01	4.3E-01
Deer Mice (diet)	Ambrose et al , 1976	Nickel sulfate hexahydrate	Oral Diet	Rat	3 generations Chronic	60 animals per dose grp	3 exposures 250, 500, 1000 ppm	Reproduction	500		0 08 BW & FCNS - EPA 1988a	40	NA	3	1	1	1	1	3	3	1.3E+01	4.0E+01
Mink (water)	Smith et al , 1993	Nickel chloride	Oral Water	Long-Evans rats	Chronic; 4 month (11 wks pre-gestation)	34 females per dose grp	4 exposures (control, XX, XX, XX ppm)	Reproduction		1 3	1 None Required	NA	1 30	5	1	1	1	1	5	5	8.7E-02	2.6E-01
Mink (diet)	Ambrose et al , 1976	Nickel sulfate hexahydrate	Oral Diet	Rat	3 generations Chronic	animals per dos	3 exposures 250, 500, 1000 ppm	Reproduction	500		0 08 BW & FCNS - EPA 1988a	40	NA	5	1	1	1	1	5	5	8.0E+00	2.4E+01
Masked Shrew (water)	Smith et al , 1993	Nickel chloride	Oral Water	Long-Evans rats	Chronic; 4 month (11 wks pre-gestation)	34 females per dose grp	4 exposures (control, XX, XX, XX ppm)	Reproduction		1 3	1 None Required	NA	1 30	5	1	1	1	1	5	5	8.7E-02	2.6E-01
Masked Shrew (diet)	Ambrose et al , 1976	Nickel sulfate hexahydrate	Oral Diet	Rat	3 generations Chronic	60 animals per dose grp	3 exposures 250, 500, 1000 ppm	Reproduction	500		0 08 BW & FCNS - EPA 1988a	40	NA	5	1	1	1	1	5	5	8.0E+00	2.4E+01
Red Fox (water)	Smith et al , 1993	Nickel chloride	Oral Water	Long-Evans rats	Chronic, 4 month (11 wks pre-gestation)	34 females per dose grp	4 exposures (control, XX, XX, XX ppm)	Reproduction		1.3	1 None Required	NA	1 30	5	1	1	1	1	5	5	8.7E-02	2.6E-01
Red Fox (diet)	Ambrose et al , 1976	Nickel sulfate hexahydrate	Oral Diet	Rat	3 generations Chronic	60 animals per dose grp	3 exposures 250, 500, 1000 ppm	Reproduction	500		0 08 BW & FCNS - EPA 1988a	40	NA	5	1	1	1	1	5	5	8.0E+00	2.4E+01
American Robin (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				2.6E+00	7.7E+00
American Robin (diet)	Cain & Pafford, 1981	Nickel sulfate	Oral Diet	Mallard duck	90 days Subchronic	36 animals per dose grp	3 exposures 176, 774, 1069 ppm	Mortality; Growth; Behavior	774		0 1 From study	77.4	NA	5	3	1	1	1	15	15	5.2E+00	1.5E+01
Cliff Swallow (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				2.6E+00	7.7E+00
Cliff Swallow (diet)	Cain & Pafford, 1981	Nickel sulfate	Oral Diet	Mallard duck	90 days Subchronic	36 animals per dose grp	3 exposures 176, 774, 1069 ppm	Mortality, Growth, Behavior	774		0 1 From study	77 4	NA	5	3	1	1	1	15	15	5.2E+00	1.5E+01
American Kestrel (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				2.6E+00	7.7E+00
American Kestrel (diet)	Cain & Pafford, 1981	Nickel sulfate	Oral Diet	Mallard duck	90 days Subchronic	36 animals per dose grp	3 exposures 176, 774, 1069 ppm	Mortality, Growth; Behavior	774		0.1 From study	77.4	NA	5	3	1	1	1	15	15	5.2E+00	1.5E+01
Belted Kingfisher (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				2.6E+00	7.7E+00
Belted Kingfisher (diet)	Cain & Pafford, 1981	Nickel sulfate	Oral Diet	Mallard duck	90 days Subchronic	36 animals per dose grp	3 exposures 176, 774, 1069 ppm	Mortality; Growth; Behavior	774		0 1 From study	77.4	NA	5	3	1	1	1	15	15	5.2E+00	1.5E+01
Mallard Duck (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				2.6E+00	7.7E+00
Mallard Duck (diet)	Cain & Pafford, 1981	Nickel sulfate	Oral Diet	Mallard duck	90 days Subchronic	36 animals per dose grp	3 exposures 176, 774, 1069 ppm	Mortality, Growth, Behavior	774		0 1 From study	77 4	NA	5	3	1	1	1	15	15	5.2E+00	1.5E+01
Greater-Sage Grouse (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				2.6E+00	7.7E+00
Greater-Sage Grouse (diet)	Cain & Pafford, 1981	Nickel sulfate	Oral Diet	Mallard duck	90 days Subchronic	36 animals per dose grp	3 exposures 176, 774, 1069 ppm	Mortality, Growth, Behavior	774		0 1 From study	77 4	NA	5	3	1	1	1	15	15	5.2E+00	1.5E+01

NOAEL & LOAEL TRVs - MANGANESE

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	Study Factors: N	Study Factors: Doses	Study Factors: Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day): Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day)[1]	Uncertainty Factors (UF): Inter-species	Uncertainty Factors (UF): Duration	Uncertainty Factors (UF): Endpoint NOAEL	Uncertainty Factors (UF): Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Deer Mice (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.5E+01	4.7E+01
Deer Mice (diet)	Laskey et al 1982	Manganese oxide	Oral Diet	Rat	224 days (through gestation) Critical lifestage		3 exposures 350, 1050, 3500 ppm (+ 50 ppm basal diet)	Reproduction	1100	3550	0.08 BW & FCNS - EPA 1988a	88	284	3	1	1	1	1	3	3	2.9E+01	9.5E+01
Mink (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				8.8E+00	2.8E+01
Mink (diet)	Laskey et al 1982	Manganese oxide	Oral Diet	Rat	224 days (through gestation) Critical lifestage		3 exposures 350, 1050, 3500 ppm (+ 50 ppm basal diet)	Reproduction	1100	3550	0.08 BW & FCNS - EPA 1988a	88	284	5	1	1	1	1	5	5	1.8E+01	5.7E+01
Masked Shrew (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				8.8E+00	2.8E+01
Masked Shrew (diet)	Laskey et al 1982	Manganese oxide	Oral Diet	Rat	224 days (through gestation) Critical lifestage		3 exposures 350, 1050, 3500 ppm (+ 50 ppm basal diet)	Reproduction	1100	3550	0.08 BW & FCNS - EPA 1988a	88	284	5	1	1	1	1	5	5	1.8E+01	5.7E+01
Red Fox (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				8.8E+00	2.8E+01
Red Fox (diet)	Laskey et al 1982	Manganese oxide	Oral Diet	Rat	224 days (through gestation) Critical lifestage		3 exposures 350, 1050, 3500 ppm (+ 50 ppm basal diet)	Reproduction	1100	3550	0.08 BW & FCNS - EPA 1988a	88	284	5	1	1	1	1	5	5	1.8E+01	5.7E+01
American Robin (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				3.3E+01	9.8E+01
American Robin (diet)	Laskey and Edens 1985	Manganese oxide	Oral Diet	Japanese quail	75 days Chronic exposure		1 exposure 5000 ppm (+56 ppm basal diet)	Growth, Aggressive behavior			1 None required	NA	977 Reported in study	5	1	1	1	1	5	5	6.5E+01	2.0E+02
Cliff Swallow (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				3.3E+01	9.8E+01
Cliff Swallow (diet)	Laskey and Edens 1985	Manganese oxide	Oral Diet	Japanese quail	75 days Chronic exposure		1 exposure 5000 ppm (+56 ppm basal diet)	Growth, Aggressive behavior			1 None required	NA	977 Reported in study	5	1	1	1	1	5	5	6.5E+01	2.0E+02
American Kestrel (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				3.3E+01	9.8E+01
American Kestrel (diet)	Laskey and Edens 1985	Manganese oxide	Oral Diet	Japanese quail	75 days Chronic exposure		1 exposure 5000 ppm (+56 ppm basal diet)	Growth, Aggressive behavior			1 None required	NA	977 Reported in study	5	1	1	1	1	5	5	6.5E+01	2.0E+02
Belted Kingfisher (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				3.3E+01	9.8E+01
Belted Kingfisher (diet)	Laskey and Edens 1985	Manganese oxide	Oral Diet	Japanese quail	75 days Chronic exposure		1 exposure 5000 ppm (+56 ppm basal diet)	Growth, Aggressive behavior			1 None required	NA	977 Reported in study	5	1	1	1	1	5	5	6.5E+01	2.0E+02
Mallard Duck (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				3.3E+01	9.8E+01
Mallard Duck (diet)	Laskey and Edens 1985	Manganese oxide	Oral Diet	Japanese quail	75 days Chronic exposure		1 exposure 5000 ppm (+56 ppm basal diet)	Growth, Aggressive behavior			1 None required	NA	977 Reported in study	5	1	1	1	1	5	5	6.5E+01	2.0E+02

NOAEL & LOAEL TRVs **- MANGANESE**

Receptor	Study	Chemical	Route	Study Test Species	Study Factors				NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food / kg BW/day)	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) [1]	Uncertainty Factors (UF)							NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
					Duration	N	Doses	Endpoint			Source			Inter-species	Duration	Endpoint		Other	Total UF[5]			
																NOAEL	LOAEL		NOAEL	LOAEL		
Greater-Sage Grouse (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				3.3E+01	9.8E+01
Greater-Sage Grouse (diet)	Laskey and Edens 1985	Manganese oxide	Oral Diet	Japanese quail	75 days Chronic exposure		1 exposure 5000 ppm (+56 ppm basal diet)	Growth; Aggressive behavior			1 None required	NA	977 Reported in study	5	1	1	1	1	5	5	6.5E+01	2.0E+02

NOAEL & LOAEL TRVs **- INORGANIC MERCURY**

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	N	Doses	Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day): Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day)[1]	Uncertainty Factors (UF): Inter-species	Duration	Endpoint: NOAEL	Endpoint: LOAEL	Other	Total UF[5]: NOAEL	Total UF[5]: LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Deer Mice (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				3.30	9.9
Deer Mice (diet)	Revis et al., 1989	Mercuric sulfide	Oral Diet	Mouse (*Mus* sp.)	Chronic, 20 months (included 6 month reprod.)		30 exposures (Highest dose = 13.2 mg/kg-day)	Reproduction, Mortality, Histology (liver, kidney)			1 None required	13.2	NA	2	1	1	1	1	2	2	6.6	20
Mink (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				0.69	2.1
Mink (diet)	Aulerich et al., 1974	Mercuric chloride	Oral Diet	Mink	Subchronic, 6 month Critical life stage (kit develop.)	15 animals per dose group	1 exposure (10 ppm)	Reproduction, Developmental	10		0.137 Bleavins & Aulerich, 1981	1.4	NA	1	1	1	1	1	1	1	1.4	4.1
Masked Shrew (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				1.32	4.0
Masked Shrew (diet)	Revis et al., 1989	Mercuric sulfide	Oral Diet	Mouse (*Mus* sp.)	Chronic; 20 months (included 6 month reprod.)		30 exposures (Highest dose = 13.2 mg/kg-day)	Reproduction, Mortality, Histology (liver, kidney)			1 None required	13.2	NA	5	1	1	1	1	5	5	2.6	7.9
Red Fox (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				0.17	0.5
Red Fox (diet)	Aulerich et al., 1974	Mercuric chloride	Oral Diet	Mink	Subchronic, 6 month Critical life stage (kit develop.)	15 animals per dose group	1 exposure (10 ppm)	Reproduction, Developmental	10		0.137 Bleavins & Aulerich, 1981	1.4	NA	4	1	1	1	1	4	4	0.3	1.0
American Robin (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				0.05	0.1
American Robin (diet)	Hill & Schaffner, 1976	Mercuric chloride	Oral Diet	Japanese quail	Chronic, 1 year Critical life stage (hatchling)		5 exposures (2, 4, 8, 16, 32 ppm)	Reproduction, Developmental	4	8	0.113 ORNL, 1996	0.45	0.90	5	1	1	1	1	5	5	0.09	0.18
Cliff Swallow (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				0.05	0.1
Cliff Swallow (diet)	Hill & Schaffner, 1976	Mercuric chloride	Oral Diet	Japanese quail	Chronic, 1 year Critical life stage (hatchling)		5 exposures (2, 4, 8, 16, 32 ppm)	Reproduction, Developmental	4	8	0.113 ORNL, 1996	0.45	0.90	5	1	1	1	1	5	5	0.09	0.18
American Kestrel (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				0.05	0.1
American Kestrel (diet)	Hill & Schaffner, 1976	Mercuric chloride	Oral Diet	Japanese quail	Chronic; 1 year Critical life stage (hatchling)		5 exposures (2, 4, 8, 16, 32 ppm)	Reproduction, Developmental	4	8	0.113 ORNL, 1996	0.45	0.90	5	1	1	1	1	5	5	0.09	0.18
Belted Kingfisher (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				0.05	0.1
Belted Kingfisher (diet)	Hill & Schaffner, 1976	Mercuric chloride	Oral Diet	Japanese quail	Chronic, 1 year Critical life stage (hatchling)		5 exposures (2, 4, 8, 16, 32 ppm)	Reproduction, Developmental	4	8	0.113 ORNL, 1996	0.45	0.90	5	1	1	1	1	5	5	0.09	0.18
Mallard Duck (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				0.05	0.1
Mallard Duck (diet)	Hill & Schaffner, 1976	Mercuric chloride	Oral Diet	Japanese quail	Chronic, 1 year Critical life stage (hatchling)		5 exposures (2, 4, 8, 16, 32 ppm)	Reproduction, Developmental	4	8	0.113 ORNL, 1996	0.45	0.90	5	1	1	1	1	5	5	0.09	0.18

NOAEL & LOAEL TRVs - INORGANIC MERCURY

					Study Factors						Conversion Factor (kg food/ kg BW/day)			Uncertainty Factors (UF)								
Receptor	Study	Chemical	Route	Study Test Species	Duration	N	Doses	Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day)[1]	Inter-species	Duration	Endpoint NOAEL	Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Greater-Sage Grouse (water)	**No Reliable TRV Establishing Studies Found** Derive from Dietary TRV[4]																				0.05	0.1
Greater-Sage Grouse (diet)	Hill & Schaffner, 1976	Mercuric chloride	Oral Diet	Japanese quail	Chronic, 1 year Critical life stage (hatchling)		5 exposures (2, 4, 8, 16, 32 ppm)	Reproduction, Developmental	4	8	0.113 ORNL, 1996	0.45	0.90	5	1	1	1	1	5	5	0.09	0.18

NOAEL & LOAEL TRVs - ORGANIC MERCURY

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	Study Factors: N	Study Factors: Doses	Study Factors: Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day): Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day)[1]	Uncertainty Factors (UF): Inter-species	Uncertainty Factors (UF): Duration	Uncertainty Factors (UF): Endpoint NOAEL	Uncertainty Factors (UF): Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Deer Mice (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				0.004	0.019
Deer Mice (diet)	Verschuuren et al., 1976	Methylmercury chloride	Oral Diet	Rat	Chronic, 2 year	sex per dose group	4 exposures (0 control, 0.1, 0.5, 2.5 ppm)	Reproduction, Histology	0.5	2.5	0.045 Measures in study controls	0.02	0.11	3	1	1	1	1	3	3	0.01	0.04
Mink (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				0.04	0.07
Mink (diet)	Wobeser et al., 1976	Methylmercury chloride	Oral Diet	Mink	Subchronic; 93 days	5 females per dose group	6 exposures (0 control, 1.1, 1.8, 4.8, 8.3, 15 ppm)	Mortality, Clinical tox (weight loss, ataxia)	1.1	1.8	0.22 USEPA, 1993	0.24	0.40	1	3	1	1	1	3	3	0.08	0.13
Masked Shrew (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				0.002	0.011
Masked Shrew (diet)	Verschuuren et al., 1976	Methylmercury chloride	Oral Diet	Rat	Chronic, 2 year	sex per dose group	4 exposures (0 control, 0.1, 0.5, 2.5 ppm)	Reproduction, Histology	0.5	2.5	0.045 Measures in study controls	0.02	0.11	5	1	1	1	1	5	5	0.005	0.02
Red Fox (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				0.03	0.05
Red Fox (diet)	Wobeser et al., 1976	Methylmercury chloride	Oral Diet	Mink	Subchronic, 93 days	5 females per dose group	6 exposures (0 control, 1.1, 1.8, 4.8, 8.3, 15 ppm)	Mortality, Clinical tox (weight loss, ataxia)	1.1	1.8	0.22 USEPA, 1993	0.24	0.40	4	1	1	1	1	4	4	0.06	0.10
American Robin (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				0.02	0.1
American Robin (diet)	Hill & Soares, 1984	Methylmercury chloride	Oral Diet	Japanese quail	Chronic, 9 weeks Critical life stage	15 animals per dose group	5 exposures (0 control, 0.125, 0.5, 2, 8 ppm)	Survivability	2	8	0.113 ORNL, 1996	0.23	0.90	5	1	1	1	1	5	5	0.05	0.18
Cliff Swallow (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				0.02	0.09
Cliff Swallow (diet)	Hill & Soares, 1984	Methylmercury chloride	Oral Diet	Japanese quail	Chronic, 9 weeks Critical life stage	15 animals per dose group	5 exposures (0 control, 0.125, 0.5, 2, 8 ppm)	Survivability	2	8	0.113 ORNL, 1996	0.23	0.90	5	1	1	1	1	5	5	0.05	0.18
American Kestrel (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				0.02	0.1
American Kestrel (diet)	Hill & Soares, 1984	Methylmercury chloride	Oral Diet	Japanese quail	Chronic, 9 weeks Critical life stage	15 animals per dose group	5 exposures (0 control, 0.125, 0.5, 2, 8 ppm)	Survivability	2	8	0.113 ORNL, 1996	0.23	0.90	5	1	1	1	1	5	5	0.05	0.18
Belted Kingfisher (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				0.02	0.1
Belted Kingfisher (diet)	Hill & Soares, 1984	Methylmercury chloride	Oral Diet	Japanese quail	Chronic, 9 weeks Critical life stage	15 animals per dose group	5 exposures (0 control, 0.125, 0.5, 2, 8 ppm)	Survivability	2	8	0.113 ORNL, 1996	0.23	0.90	5	1	1	1	1	5	5	0.05	0.18
Mallard Duck (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				0.02	0.1
Mallard Duck (diet)	Hill & Soares, 1984	Methylmercury chloride	Oral Diet	Japanese quail	Chronic, 9 weeks Critical life stage	15 animals per dose group	5 exposures (0 control, 0.125, 0.5, 2, 8 ppm)	Survivability	2	8	0.113 ORNL, 1996	0.23	0.90	5	1	1	1	1	5	5	0.05	0.18

NOAEL & LOAEL TRVs - ORGANIC MERCURY

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	Study Factors: N	Study Factors: Doses	Study Factors: Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day) Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day)[1]	Uncertainty Factors (UF): Inter-species	Uncertainty Factors (UF): Duration	Uncertainty Factors (UF): Endpoint NOAEL	Uncertainty Factors (UF): Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Greater-Sage Grouse (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				0.02	0.1
Greater-Sage Grouse (diet)	Hill & Soares, 1984	Methylmercury chloride	Oral Diet	Japanese quail	Chronic, 9 weeks Critical life stage	15 animals per dose group	5 exposures (0 control, 0.125, 0.5, 2, 8 ppm)	Survivability	2	8	0.113 ORNL, 1996	0.23	0.90	5	1	1	1	1	5	5	0.05	0.18

NOAEL & LOAEL TRVs - SELENIUM

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	N	Doses	Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day) Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) [1]	Uncertainty Factors (UF): Inter-species	Duration	Endpoint NOAEL	Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Deer Mice (water)	Rosenfeld & Beath 1954	Potassium selenate	Oral Water	Rat	1 year (2 generations) Critical lifestage		3 exposures 1.5, 2.5, 7.5 mg/L	Reproduction	1.5	2.5	0.13 BW & WCNS - EPA 1988a	0.20	0.33	3	1	1	1	1	3	3	6.6E-02	1.1E-01
Deer Mice (diet)	No Reliable TRV Establishing Study Derive from water TRV																				1.3E-01	2.2E-01
Mink (water)	Rosenfeld & Beath 1954	Potassium selenate	Oral Water	Rat	1 year (2 generations) Critical lifestage		3 exposures 1.5, 2.5, 7.5 mg/L	Reproduction	1.5	2.5	0.13 BW & WCNS - EPA 1988a	0.20	0.33	5	1	1	1	1	5	5	3.9E-02	6.6E-02
Mink (diet)	No Reliable TRV Establishing Study Derive from water TRV																				7.9E-02	1.3E-01
Masked Shrew (water)	Rosenfeld & Beath 1954	Potassium selenate	Oral Water	Rat	1 year (2 generations) Critical lifestage		3 exposures 1.5, 2.5, 7.5 mg/L	Reproduction	1.5	2.5	0.13 BW & WCNS - EPA 1988a	0.20	0.33	5	1	1	1	1	5	5	3.9E-02	6.6E-02
Masked Shrew (diet)	No Reliable TRV Establishing Study Derive from water TRV																				7.9E-02	1.3E-01
Red Fox (water)	Rosenfeld & Beath 1954	Potassium selenate	Oral Water	Rat	1 year (2 generations) Critical lifestage		3 exposures 1.5, 2.5, 7.5 mg/L	Reproduction	1.5	2.5	0.13 BW & WCNS - EPA 1988a	0.20	0.33	5	1	1	1	1	5	5	3.9E-02	6.6E-02
Red Fox (diet)	No Reliable TRV Establishing Study Derive from water TRV																				7.9E-02	1.3E-01
American Robin (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				5.0E-02	1.0E-01
American Robin (diet)	Heinz et al 1987	Sodium selenite	Oral Diet	Mallard	78 days Critical lifestage		5 exposures 1, 5, 10, 25, 100 ppm	Reproduction	5	10	0.10 Measured in study	0.5	1.0	5	1	1	1	1	5	5	1.0E-01	2.0E-01
Cliff Swallow (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				5.0E-02	1.0E-01
Cliff Swallow (diet)	Heinz et al 1987	Sodium selenite	Oral Diet	Mallard	78 days Critical lifestage		5 exposures 1, 5, 10, 25, 100 ppm	Reproduction	5	10	0.10 Measured in study	0.5	1.0	5	1	1	1	1	5	5	1.0E-01	2.0E-01
American Kestrel (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				5.0E-02	1.0E-01
American Kestrel (diet)	Heinz et al 1987	Sodium selenite	Oral Diet	Mallard	78 days Critical lifestage		5 exposures 1, 5, 10, 25, 100 ppm	Reproduction	5	10	0.10 Measured in study	0.5	1.0	5	1	1	1	1	5	5	1.0E-01	2.0E-01
Belted Kingfisher (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				5.0E-02	1.0E-01
Belted Kingfisher (diet)	Heinz et al 1987	Sodium selenite	Oral Diet	Mallard	78 days Critical lifestage		5 exposures 1, 5, 10, 25, 100 ppm	Reproduction	5	10	0.10 Measured in study	0.5	1.0	5	1	1	1	1	5	5	1.0E-01	2.0E-01
Mallard Duck (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				5.0E-02	1.0E-01
Mallard Duck (diet)	Heinz et al 1987	Sodium selenite	Oral Diet	Mallard	78 days Critical lifestage		5 exposures 1, 5, 10, 25, 100 ppm	Reproduction	5	10	0.10 Measured in study	0.5	1.0	5	1	1	1	1	5	5	1.0E-01	2.0E-01

NOAEL & LOAEL TRVs - SELENIUM

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	Study Factors: N	Study Factors: Doses	Study Factors: Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day): Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) [1]	Uncertainty Factors (UF): Inter-species	Uncertainty Factors (UF): Duration	Uncertainty Factors (UF): Endpoint NOAEL	Uncertainty Factors (UF): Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Greater-Sage Grouse (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				5.0E-02	1.0E-01
Greater-Sage Grouse (diet)	Heinz et al 1987	Sodium selenite	Oral Diet	Mallard	78 days Critical lifestage		5 exposures 1, 5, 10, 25, 100 ppm	Reproduction	5	10	0.10 Measured in study	0.5	1.0	5	1	1	1	1	5	5	1.0E-01	2.0E-01

NOAEL & LOAEL TRVs - SILVER

Receptor	Study	Chemical	Route	Study Test Species	Study Factors				NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day)	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day)[1]	Uncertainty Factors (UF)					Total UF[3]		NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
					Duration	N	Doses	Endpoint			Source			Inter-species	Duration	Endpoint NOAEL	Endpoint LOAEL	Other	NOAEL	LOAEL		
Deer Mice (water)	No Reliable TRV Establishing Study																				NA	NA
Deer Mice (diet)	No Reliable TRV Establishing Study																				NA	NA
Mink (water)	No Reliable TRV Establishing Study																				NA	NA
Mink (diet)	No Reliable TRV Establishing Study																				NA	NA
Masked Shrew (water)	No Reliable TRV Establishing Study																				NA	NA
Masked Shrew (diet)	No Reliable TRV Establishing Study																				NA	NA
Red Fox (water)	No Reliable TRV Establishing Study																				NA	NA
Red Fox (diet)	No Reliable TRV Establishing Study																				NA	NA
American Robin (water)	No Reliable TRV Establishing Study																				NA	NA
American Robin (diet)	No Reliable TRV Establishing Study																				NA	NA
Cliff Swallow (water)	No Reliable TRV Establishing Study																				NA	NA
Cliff Swallow (diet)	No Reliable TRV Establishing Study																				NA	NA
American Kestrel (water)	No Reliable TRV Establishing Study																				NA	NA
American Kestrel (diet)	No Reliable TRV Establishing Study																				NA	NA
Belted Kingfisher (water)	No Reliable TRV Establishing Study																				NA	NA
Belted Kingfisher (diet)	No Reliable TRV Establishing Study																				NA	NA
Mallard Duck (water)	No Reliable TRV Establishing Study																				NA	NA
Mallard Duck (diet)	No Reliable TRV Establishing Study																				NA	NA
Greater-Sage Grouse (water)	No Reliable TRV Establishing Study																				NA	NA
Greater-Sage Grouse (diet)	No Reliable TRV Establishing Study																				NA	NA

NOAEL & LOAEL TRVs - THALLIUM

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	Study Factors: N	Study Factors: Doses	Study Factors: Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day): Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) [1]	Uncertainty Factors (UF): Inter-species	Uncertainty Factors (UF): Duration	Uncertainty Factors (UF): Endpoint NOAEL	Uncertainty Factors (UF): Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Deer Mice (water)	Formigli et al 1986	Thallium sulfate	Oral Water	Rat	60 days Subchronic		1 exposure 10 ppm	Reproduction Male testicular function		10	0.007 Measured in study	NA	0.074	3	5 Subchronic	1	1	1	15	15	1.6E-03	4.9E-03
Deer Mice (diet)	No Reliable TRV Establishing Study Derive from water TRV																				3.3E-03	9.9E-03
Mink (water)	Formigli et al 1986	Thallium sulfate	Oral Water	Rat	60 days Subchronic		1 exposure 10 ppm	Reproduction Male testicular function		10	0.007 Measured in study	NA	0.074	5	5 Subchronic	1	1	1	25	25	9.9E-04	3.0E-03
Mink (diet)	No Reliable TRV Establishing Study Derive from water TRV																				2.0E-03	5.9E-03
Masked Shrew (water)	Formigli et al 1986	Thallium sulfate	Oral Water	Rat	60 days Subchronic		1 exposure 10 ppm	Reproduction Male testicular function		10	0.007 Measured in study	NA	0.074	5	5 Subchronic	1	1	1	25	25	9.9E-04	3.0E-03
Masked Shrew (diet)	No Reliable TRV Establishing Study Derive from water TRV																				2.0E-03	5.9E-03
Red Fox (water)	Formigli et al 1986	Thallium sulfate	Oral Water	Rat	60 days Subchronic		1 exposure 10 ppm	Reproduction Male testicular function		10	0.007 Measured in study	NA	0.074	5	5 Subchronic	1	1	1	25	25	9.9E-04	3.0E-03
Red Fox (diet)	No Reliable TRV Establishing Study Derive from water TRV																				2.0E-03	5.9E-03
American Robin (water)	No Reliable TRV Establishing Study																				NA	NA
American Robin (diet)	No Reliable TRV Establishing Study																				NA	NA
Cliff Swallow (water)	No Reliable TRV Establishing Study																				NA	NA
Cliff Swallow (diet)	No Reliable TRV Establishing Study																				NA	NA
American Kestrel (water)	No Reliable TRV Establishing Study																				NA	NA
American Kestrel (diet)	No Reliable TRV Establishing Study																				NA	NA
Belted Kingfisher (water)	No Reliable TRV Establishing Study																				NA	NA
Belted Kingfisher (diet)	No Reliable TRV Establishing Study																				NA	NA
Mallard Duck (water)	No Reliable TRV Establishing Study																				NA	NA
Mallard Duck (diet)	No Reliable TRV Establishing Study																				NA	NA
Greater-Sage Grouse (water)	No Reliable TRV Establishing Study																				NA	NA
Greater-Sage Grouse (diet)	No Reliable TRV Establishing Study																				NA	NA

NOAEL & LOAEL TRVs - **VANADIUM**

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	Study Factors: N	Study Factors: Doses	Study Factors: Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day): Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) [1]	Uncertainty Factors (UF): Inter-species	Uncertainty Factors (UF): Duration	Uncertainty Factors (UF): Endpoint NOAEL	Uncertainty Factors (UF): Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Deer Mice (water)	Domingo et al 1986	Sodium metavanadate	Oral Gavage	Rat	60 days pre-gestation through lactation, Chronic		3 exposures 5, 10, 20 mg/kg-day	Reproduction		5	1 None required	NA	5.0	3	1	1	1	1	3	3	5.6E-01	1.7E+00
Deer Mice (diet)	**No Reliable TRV Establishing Study Derive from water TRV**																				1.1E+00	3.3E+00
Mink (water)	Domingo et al 1986	Sodium metavanadate	Oral Gavage	Rat	60 days pre-gestation through lactation, Chronic		3 exposures 5, 10, 20 mg/kg-day	Reproduction		5	1 None required	NA	5.0	5	1	1	1	1	5	5	3.3E-01	1.0E+00
Mink (diet)	**No Reliable TRV Establishing Study Derive from water TRV**																				6.7E-01	2.0E+00
Masked Shrew (water)	Domingo et al 1986	Sodium metavanadate	Oral Gavage	Rat	60 days pre-gestation through lactation, Chronic		3 exposures 5, 10, 20 mg/kg-day	Reproduction		5	1 None required	NA	5.0	5	1	1	1	1	5	5	3.3E-01	1.0E+00
Masked Shrew (diet)	**No Reliable TRV Establishing Study Derive from water TRV**																				6.7E-01	2.0E+00
Red Fox (water)	Domingo et al 1986	Sodium metavanadate	Oral Gavage	Rat	60 days pre-gestation through lactation, Chronic		3 exposures 5, 10, 20 mg/kg-day	Reproduction		5	1 None required	NA	5.0	5	1	1	1	1	5	5	3.3E-01	1.0E+00
Red Fox (diet)	**No Reliable TRV Establishing Study Derive from water TRV**																				6.7E-01	2.0E+00
American Robin (water)	**No Reliable TRV Establishing Study Derive from dietary TRV**																				1.1E+00	3.4E+00
American Robin (diet)	White & Dieter 1978	Vanadyl sulfate	Oral Diet	Mallard	12 weeks Chronic		3 exposures 2.84, 10.36, 110 ppm	Mortality; Body weight	110		0.10 Measured in study	11.38	NA	5	1	1	1	1	5	5	2.3E+00	6.8E+00
Cliff Swallow (water)	**No Reliable TRV Establishing Study Derive from dietary TRV**																				1.1E+00	3.4E+00
Cliff Swallow (diet)	White & Dieter 1978	Vanadyl sulfate	Oral Diet	Mallard	12 weeks Chronic		3 exposures 2.84, 10.36, 110 ppm	Mortality; Body weight	110		0.10 Measured in study	11.38	NA	5	1	1	1	1	5	5	2.3E+00	6.8E+00
American Kestrel (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.1E+00	3.4E+00
American Kestrel (diet)	White & Dieter 1978	Vanadyl sulfate	Oral Diet	Mallard	12 weeks Chronic		3 exposures 2.84, 10.36, 110 ppm	Mortality; Body weight	110		0.10 Measured in study	11.38	NA	5	1	1	1	1	5	5	2.3E+00	6.8E+00
Belted Kingfisher (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.1E+00	3.4E+00
Belted Kingfisher (diet)	White & Dieter 1978	Vanadyl sulfate	Oral Diet	Mallard	12 weeks Chronic		3 exposures 2.84, 10.36, 110 ppm	Mortality; Body weight	110		0.10 Measured in study	11.38	NA	5	1	1	1	1	5	5	2.3E+00	6.8E+00
Mallard Duck (water)	**No Reliable TRV Establishing Study Derive from dietary TRV**																				1.1E+00	3.4E+00
Mallard Duck (diet)	White & Dieter 1978	Vanadyl sulfate	Oral Diet	Mallard	12 weeks Chronic		3 exposures 2.84, 10.36, 110 ppm	Mortality; Body weight	110		0.10 Measured in study	11.38	NA	5	1	1	1	1	5	5	2.3E+00	6.8E+00
Greater-Sage Grouse (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.1E+00	3.4E+00
Greater-Sage Grouse (diet)	White & Dieter 1978	Vanadyl sulfate	Oral Diet	Mallard	12 weeks Chronic		3 exposures 2.84, 10.36, 110 ppm	Mortality; Body weight	110		0.10 Measured in study	11.38	NA	5	1	1	1	1	5	5	2.3E+00	6.8E+00

NOAEL & LOAEL TRVs - ZINC

Receptor	Study	Chemical	Route	Study Test Species	Study Factors: Duration	Study Factors: N	Study Factors: Doses	Study Factors: Endpoint	NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day) Source	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) [3]	Uncertainty Factors (UF): Inter-species	Uncertainty Factors (UF): Duration	Uncertainty Factors (UF): Endpoint NOAEL	Uncertainty Factors (UF): Endpoint LOAEL	Other	Total UF[5] NOAEL	Total UF[5] LOAEL	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
Deer Mice (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				20	40
Deer Mice (diet)	Schlicker & Cox, 1968	Zinc oxide	Oral Diet	Sprague-Dawley rat	Chronic	10 animals per dose group	2 exposures (0.2%, 0.4% ZnO)	Fetal Development, Growth	2000	4000	0.06 Sax & Lewis, 1989	120	240	3	1	1	1	1	3	3	40	80
Mink (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				155.5	466.5
Mink (diet)	Aulerich et al., 1991	Zinc sulfate	Oral Diet	Mink	Chronic	12 animals per dose group	4 exposures (0, 500, 1000, 1500 ppm)	Survivability, Growth			1 None required	311 ave. of male & female kits	NA	1	1	1	1	1	1	1	311	933
Masked Shrew (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				12	24
Masked Shrew (diet)	Schlicker & Cox, 1968	Zinc oxide	Oral Diet	Sprague-Dawley rat	Chronic	10 animals per dose group	2 exposures (0.2%, 0.4% ZnO)	Fetal Development, Growth	2000	4000	0.06 Sax & Lewis, 1989	120	240	5	1	1	1	1	5	5	24	48
Red Fox (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				38.9	116.6
Red Fox (diet)	Aulerich et al., 1991	Zinc sulfate	Oral Diet	Mink	Chronic	12 animals per dose group	4 exposures (0, 500, 1000, 1500 ppm)	Survivability Growth			1 None required	311 ave. of male & female kits	NA	4	1	1	1	1	4	4	78	233
American Robin (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				13	39
American Robin (diet)	Stahl et al., 1989	Zinc sulfate	Oral Diet	White leghorn hen	Chronic, 44 weeks Critical life stage		3 exposures (28 control, 20, 200, 2000 ppm)	Reproduction	2,028		0.0646 Measured in study (NOAEL group)	131	NA	5	1	1	1	1	5	5	26	79
Cliff Swallow (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				13	39
Cliff Swallow (diet)	Stahl et al., 1989	Zinc sulfate	Oral Diet	White leghorn hen	Chronic; 44 weeks Critical life stage		3 exposures (28 control, 20, 200, 2000 ppm)	Reproduction	2,028		0.0646 Measured in study (NOAEL group)	131	NA	5	1	1	1	1	5	5	26	79
American Kestrel (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				13	39
American Kestrel (diet)	Stahl et al., 1989	Zinc sulfate	Oral Diet	White leghorn hen	Chronic, 44 weeks Critical life stage		3 exposures (28 control, 20, 200, 2000 ppm)	Reproduction	2,028		0.0646 Measured in study (NOAEL group)	131	NA	5	1	1	1	1	5	5	26	79
Belted Kingfisher (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				13	39
Belted Kingfisher (diet)	Stahl et al., 1989	Zinc sulfate	Oral Diet	White leghorn hen	Chronic, 44 weeks Critical life stage		3 exposures (28 control, 20, 200, 2000 ppm)	Reproduction	2,028		0.0646 Measured in study (NOAEL group)	131	NA	5	1	1	1	1	5	5	26	79
Mallard Duck (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				13	39
Mallard Duck (diet)	Stahl et al., 1989	Zinc sulfate	Oral Diet	White leghorn hen	Chronic, 44 weeks Critical life stage		3 exposures (28 control, 20, 200, 2000 ppm)	Reproduction	2,028		0.0646 Measured in study (NOAEL group)	131	NA	5	1	1	1	1	5	5	26	79
Greater-Sage Grouse (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV[4]																				13	39

NOAEL & LOAEL TRVs - ZINC

Receptor	Study	Chemical	Route	Study Test Species	Study Factors				NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day)	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) [1]	Uncertainty Factors (UF)					Total UF[5]		NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
					Duration	N	Doses	Endpoint			Source			Inter-species	Duration	Endpoint NOAEL	Endpoint LOAEL	Other	NOAEL	LOAEL		
Greater-Sage Grouse (diet)	Stahl et al , 1989	Zinc sulfate	Oral Diet	White leghorn hen	Chronic, 44 weeks Critical life stage		3 exposures (28 control, 20, 200, 2000 ppm)	Reproduction	2,028		0.0646 Measured in study (NOAEL group)	131	NA	5	1	1	1	1	5	5	26	79

APPENDIX E

CALCULATION OF EXPOSURE AND HAZARD FOR WILDLIFE RECEPTORS

Ingestion of Surface Water
Incidental Ingestion of Sediment
Ingestion of Seep Water
Incidental Ingestion of Soils & Tailings
Ingestion of Food Items
(Plants, Earthworms, Small Mammals, Fish and Benthic Invertebrates)

Hazard Quotients (HQs) for the Ingestion of Surface Water
Wildlife Receptor - Greater-Sage Grouse

Richardson Flat Tailings
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (ug/L)	Calculated Dose (mg/kg BW/day)	TRV(mg/kg BW/day)		Surface Water HQ	
				NOAEL	LOAEL	NOAEL	LOAEL
Silver Creek - upstream	Arsenic	18	0.0080	0.4	3.5	2E-02	2E-03
	Lead	953	0.4273	0.44	0.9	1E+00	5E-01
	Mercury	90.0	0.0404	0.0	0.1	9E-01	4E-01
	Selenium	4.1	0.0019	0.05	0.10	4E-02	2E-02
	Zinc	5,666	2.5395	13	39	2E-01	6E-02
	TOTAL HI					**2E+00**	*1E+00*
Silver Creek - downstream	Arsenic	23.0	0.0103	0.4	3.5	3E-02	3E-03
	Lead	165	0.0741	0.44	0.9	2E-01	8E-02
	Mercury	75.1	0.0337	0.0	0.1	7E-01	4E-01
	Selenium	5.0	0.0022	0.05	0.10	4E-02	2E-02
	Zinc	1,426	0.6394	13	39	5E-02	2E-02
	TOTAL HI					*1E+00*	*5E-01*
South Diversion Ditch	Arsenic	68	0.0306	0.4	3.5	8E-02	9E-03
	Lead	17	0.0077	0.44	0.9	2E-02	9E-03
	Mercury	0.5	0.0002	0.0	0.1	5E-03	2E-03
	Selenium	4.7	0.0021	0.05	0.10	4E-02	2E-02
	Zinc	2,380	1.0667	13	39	8E-02	3E-02
	TOTAL HI					*2E-01*	*7E-02*
Ponded Water	Arsenic	10	0.0045	0.4	3.5	1E-02	1E-03
	Lead	2.5	0.0011	0.44	0.9	3E-03	1E-03
	Mercury	0.3	0.00011	0.0	0.1	2E-03	1E-03
	Selenium	2.5	0.0011	0.05	0.10	2E-02	1E-02
	Zinc	11	0.0049	13	39	4E-04	1E-04
	TOTAL HI					*4E-02*	*2E-02*
Unnamed Drainages	Arsenic	17	0.0076	0.4	3.5	2E-02	2E-03
	Lead	7.0	0.0031	0.44	0.9	7E-03	4E-03
	Mercury	0.2	0.00011	0.0	0.1	2E-03	1E-03
	Selenium	2.0	0.0009	0.05	0.10	2E-02	9E-03
	Zinc	98	0.0439	13	39	3E-03	1E-03
	TOTAL HI					*5E-02*	*2E-02*

NA = Not Available
NC = Not Calculated

HQs greater than 1 are shown in **boldface** type.
EPC is equal to the minimum of the 95UCL and the maximum.
Mercury TRV is based on inorganic mercury.

Hazard Quotients (HQs) for the Ingestion of Surface Water
Wildlife Receptor - Mallard Duck

Richardson Flat Tailings
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (ug/L)	Calculated Dose (mg/kg BW/day)	TRV(mg/kg BW/day)		Surface Water HQ	
				NOAEL	LOAEL	NOAEL	LOAEL
Silver Creek - upstream	Arsenic	18	0.0010	0.4	3.5	2E-03	3E-04
	Lead	953	0.0540	0.44	0.9	1E-01	6E-02
	Mercury	90.0	0.0051	0.0	0.1	1E-01	6E-02
	Selenium	4.1	0.0002	0.05	0.10	5E-03	2E-03
	Zinc	5,666	0.3207	13	39	2E-02	8E-03
	TOTAL HI					*3E-01*	*1E-01*
Silver Creek - downstream	Arsenic	23.0	0.0013	0.4	3.5	3E-03	4E-04
	Lead	165	0.0094	0.44	0.9	2E-02	1E-02
	Mercury	75.1	0.0043	0.0	0.1	9E-02	5E-02
	Selenium	5.0	0.0003	0.05	0.10	6E-03	3E-03
	Zinc	1,426	0.0807	13	39	6E-03	2E-03
	TOTAL HI					*1E-01*	*6E-02*
South Diversion Ditch	Arsenic	68	0.0039	0.4	3.5	9E-03	1E-03
	Lead	17	0.0010	0.44	0.9	2E-03	1E-03
	Mercury	0.5	0.0000	0.0	0.1	6E-04	3E-04
	Selenium	4.7	0.0003	0.05	0.10	5E-03	3E-03
	Zinc	2,380	0.1347	13	39	1E-02	3E-03
	TOTAL HI					*3E-02*	*9E-03*
Ponded Water	Arsenic	10	0.0006	0.4	3.5	1E-03	2E-04
	Lead	2.5	0.0001	0.44	0.9	3E-04	2E-04
	Mercury	0.3	0.00001	0.0	0.1	3E-04	2E-04
	Selenium	2.5	0.0001	0.05	0.10	3E-03	1E-03
	Zinc	11	0.0006	13	39	5E-05	2E-05
	TOTAL HI					*5E-03*	*2E-03*
Unnamed Drainages	Arsenic	17	0.0010	0.4	3.5	2E-03	3E-04
	Lead	7.0	0.0004	0.44	0.9	9E-04	5E-04
	Mercury	0.2	0.00001	0.0	0.1	3E-04	2E-04
	Selenium	2.0	0.0001	0.05	0,10	2E-03	1E-03
	Zinc	98	0.0055	13	39	4E-04	1E-04
	TOTAL HI					*6E-03*	*2E-03*

NA = Not Available
NC = Not Calculated

HQs greater than 1 are shown in **boldface** type.
EPC is equal to the minimum of the 95UCL and the maximum.
Mercury TRV is based on inorganic mercury.

Hazard Quotients (HQs) for the Ingestion of Surface Water
Wildlife Receptor - Belted Kingfisher

Richardson Flat Tailings
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (ug/L)	Calculated Dose (mg/kg BW/day)	TRV(mg/kg BW/day)		Surface Water HQ	
				NOAEL	LOAEL	NOAEL	LOAEL
Silver Creek - upstream	Arsenic	18	0.0020	0.4	3.5	5E-03	6E-04
	Lead	953	0.1057	0.44	0.9	2E-01	1E-01
	Mercury	90.0	0.0100	0.0	0.1	2E-01	1E-01
	Selenium	4.1	0.0005	0.05	0.10	9E-03	5E-03
	Zinc	5,666	0.6283	13	39	5E-02	2E-02
	TOTAL HI					*5E-01*	*3E-01*
Silver Creek - downstream	Arsenic	23.0	0.0026	0.4	3.5	6E-03	7E-04
	Lead	165	0.0183	0.44	0.9	4E-02	2E-02
	Mercury	75.1	0.0083	0.0	0.1	2E-01	9E-02
	Selenium	5.0	0.0006	0.05	0.10	1E-02	6E-03
	Zinc	1,426	0.1582	13	39	1E-02	4E-03
	TOTAL HI					*3E-01*	*1E-01*
South Diversion Ditch	Arsenic	68	0.0076	0.4	3.5	2E-02	2E-03
	Lead	17	0.0019	0.44	0.9	4E-03	2E-03
	Mercury	0.5	0.0001	0.0	0.1	1E-03	6E-04
	Selenium	4.7	0.0005	0.05	0.10	1E-02	5E-03
	Zinc	2,380	0.2639	13	39	2E-02	7E-03
	TOTAL HI					*5E-02*	*2E-02*
Ponded Water	Arsenic	10	0.0011	0.4	3.5	3E-03	3E-04
	Lead	2.5	0.0003	0.44	0.9	6E-04	3E-04
	Mercury	0.3	0.00003	0.0	0.1	6E-04	3E-04
	Selenium	2.5	0.0003	0.05	0.10	6E-03	3E-03
	Zinc	11	0.0012	13	39	9E-05	3E-05
	TOTAL HI					*1E-02*	*4E-03*
Unnamed Drainages	Arsenic	17	0.0019	0.4	3.5	5E-03	5E-04
	Lead	7.0	0.0008	0.44	0.9	2E-03	9E-04
	Mercury	0.2	0.00003	0.0	0.1	6E-04	3E-04
	Selenium	2.0	0.0002	0.05	0.10	4E-03	2E-03
	Zinc	98	0.0109	13	39	8E-04	3E-04
	TOTAL HI					*1E-02*	*4E-03*

NA = Not Available
NC = Not Calculated

HQs greater than 1 are shown in **boldface** type.
EPC is equal to the minimum of the 95UCL and the maximum.
Mercury TRV is based on inorganic mercury.

Hazard Quotients (HQs) for the Ingestion of Surface Water
Wildlife Receptor - American Robin

Richardson Flat Tailings
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (ug/L)	Calculated Dose (mg/kg BW/day)	TRV(mg/kg BW/day)		Surface Water HQ	
				NOAEL	LOAEL	NOAEL	LOAEL
Silver Creek - upstream	Arsenic	18	0.0024	0.4	3.5	6E-03	7E-04
	Lead	953	0.1287	0.44	0.9	3E-01	1E-01
	Mercury	90.0	0.0122	0.0	0.1	3E-01	1E-01
	Selenium	4.1	0.0006	0.05	0.10	1E-02	6E-03
	Zinc	5,666	0.7650	13	39	6E-02	2E-02
	TOTAL HI					*6E-01*	*3E-01*
Silver Creek - downstream	Arsenic	23.0	0.0031	0.4	3.5	8E-03	9E-04
	Lead	165	0.0223	0.44	0.9	5E-02	3E-02
	Mercury	75.1	0.0101	0.0	0.1	2E-01	1E-01
	Selenium	5.0	0.0007	0.05	0.10	1E-02	7E-03
	Zinc	1,426	0.1926	13	39	1E-02	5E-03
	TOTAL HI					*3E-01*	*2E-01*
South Diversion Ditch	Arsenic	68	0.0092	0.4	3.5	2E-02	3E-03
	Lead	17	0.0023	0.44	0.9	5E-03	3E-03
	Mercury	0.5	0.0001	0.0	0.1	1E-03	7E-04
	Selenium	4.7	0.0006	0.05	0.10	1E-02	6E-03
	Zinc	2,380	0.3213	13	39	2E-02	8E-03
	TOTAL HI					*7E-02*	*2E-02*
Ponded Water	Arsenic	10	0.0014	0.4	3.5	3E-03	4E-04
	Lead	2.5	0.0003	0.44	0.9	8E-04	4E-04
	Mercury	0.3	0.00003	0.0	0.1	7E-04	4E-04
	Selenium	2.5	0.0003	0.05	0.10	7E-03	3E-03
	Zinc	11	0.0015	13	39	1E-04	4E-05
	TOTAL HI					*1E-02*	*5E-03*
Unnamed Drainages	Arsenic	17	0.0023	0.4	3.5	6E-03	7E-04
	Lead	7.0	0.0009	0.44	0.9	2E-03	1E-03
	Mercury	0.2	0.00003	0.0	0.1	7E-04	4E-04
	Selenium	2.0	0.0003	0.05	0.10	5E-03	3E-03
	Zinc	98	0.0132	13	39	1E-03	3E-04
	TOTAL HI					*1E-02*	*5E-03*

NA = Not Available
NC = Not Calculated

HQs greater than 1 are shown in **boldface** type.
EPC is equal to the minimum of the 95UCL and the maximum.
Mercury TRV is based on inorganic mercury.

Hazard Quotients (HQs) for the Ingestion of Surface Water
Wildlife Receptor - American Kestrel

Richardson Flat Tailings
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (ug/L)	Calculated Dose (mg/kg BW/day)	TRV(mg/kg BW/day)		Surface Water HQ	
				NOAEL	LOAEL	NOAEL	LOAEL
Silver Creek - upstream	Arsenic	18	0.0022	0.4	3.5	5E-03	6E-04
	Lead	953	0.1148	0.44	0.9	3E-01	1E-01
	Mercury	90.0	0.0108	0.0	0.1	2E-01	1E-01
	Selenium	4.1	0.0005	0.05	0.10	1E-02	5E-03
	Zinc	5,666	0.6825	13	39	5E-02	2E-02
	TOTAL HI					*6E-01*	*3E-01*
Silver Creek - downstream	Arsenic	23.0	0.0028	0.4	3.5	7E-03	8E-04
	Lead	165	0.0199	0.44	0.9	5E-02	2E-02
	Mercury	75.1	0.0090	0.0	0.1	2E-01	1E-01
	Selenium	5.0	0.0006	0.05	0.10	1E-02	6E-03
	Zinc	1,426	0.1718	13	39	1E-02	4E-03
	TOTAL HI					*3E-01*	*1E-01*
South Diversion Ditch	Arsenic	68	0.0082	0.4	3.5	2E-02	2E-03
	Lead	17	0.0021	0.44	0.9	5E-03	2E-03
	Mercury	0.5	0.0001	0.0	0.1	1E-03	6E-04
	Selenium	4.7	0.0006	0.05	0.10	1E-02	6E-03
	Zinc	2,380	0.2867	13	39	2E-02	7E-03
	TOTAL HI					*6E-02*	*2E-02*
Ponded Water	Arsenic	10	0.0012	0.4	3.5	3E-03	3E-04
	Lead	2.5	0.0003	0.44	0.9	7E-04	3E-04
	Mercury	0.3	0.00003	0.0	0.1	7E-04	3E-04
	Selenium	2.5	0.0003	0.05	0.10	6E-03	3E-03
	Zinc	11	0.0013	13	39	1E-04	3E-05
	TOTAL HI					*1E-02*	*4E-03*
Unnamed Drainages	Arsenic	17	0.0020	0.4	3.5	5E-03	6E-04
	Lead	7.0	0.0008	0.44	0.9	2E-03	1E-03
	Mercury	0.2	0.00003	0.0	0.1	6E-04	3E-04
	Selenium	2.0	0.0002	0.05	0.10	5E-03	2E-03
	Zinc	98	0.0118	13	39	9E-04	3E-04
	TOTAL HI					*1E-02*	*5E-03*

NA = Not Available
NC = Not Calculated

HQs greater than 1 are shown in **boldface** type.
EPC is equal to the minimum of the 95UCL and the maximum.
Mercury TRV is based on inorganic mercury.

Hazard Quotients (HQs) for the Ingestion of Surface Water
Wildlife Receptor - Red Fox

Richardson Flat Tailings
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (ug/L)	Calculated Dose (mg/kg BW/day)	TRV(mg/kg BW/day)		Surface Water HQ	
				NOAEL	LOAEL	NOAEL	LOAEL
Silver Creek - upstream	Arsenic	18	0.0015	0.3	0.8	6E-03	2E-03
	Lead	953	0.0811	0.21	0.4	4E-01	2E-01
	Mercury	90.0	0.0077	0.2	0.5	4E-02	1E-02
	Selenium	4.1	0.0004	0.04	0.07	9E-03	5E-03
	Zinc	5,666	0.4822	39	117	1E-02	4E-03
	TOTAL HI					*5E-01*	*2E-01*
Silver Creek - downstream	Arsenic	23.0	0.0020	0.3	0.8	8E-03	3E-03
	Lead	165	0.0141	0.21	0.4	7E-02	3E-02
	Mercury	75.1	0.0064	0.2	0.5	4E-02	1E-02
	Selenium	5.0	0.0004	0.04	0.07	1E-02	6E-03
	Zinc	1,426	0.1214	39	117	3E-03	1E-03
	TOTAL HI					*1E-01*	*6E-02*
South Diversion Ditch	Arsenic	68	0.0058	0.3	0.8	2E-02	8E-03
	Lead	17	0.0015	0.21	0.4	7E-03	4E-03
	Mercury	0.5	0.0000	0.2	0.5	2E-04	8E-05
	Selenium	4.7	0.0004	0.04	0.07	1E-02	6E-03
	Zinc	2,380	0.2025	39	117	5E-03	2E-03
	TOTAL HI					*5E-02*	*2E-02*
Ponded Water	Arsenic	10	0.0009	0.3	0.8	3E-03	1E-03
	Lead	2.5	0.0002	0.21	0.4	1E-03	5E-04
	Mercury	0.3	0.00002	0.2	0.5	1E-04	4E-05
	Selenium	2.5	0.0002	0.04	0.07	5E-03	3E-03
	Zinc	11	0.0009	39	117	2E-05	8E-06
	TOTAL HI					*1E-02*	*5E-03*
Unnamed Drainages	Arsenic	17	0.0014	0.3	0.8	6E-03	2E-03
	Lead	7.0	0.0006	0.21	0.4	3E-03	1E-03
	Mercury	0.2	0.00002	0.2	0.5	1E-04	4E-05
	Selenium	2.0	0.0002	0.04	0.07	4E-03	3E-03
	Zinc	98	0.0083	39	117	2E-04	7E-05
	TOTAL HI					*1E-02*	*6E-03*

NA = Not Available
NC = Not Calculated

HQs greater than 1 are shown in **boldface** type.
EPC is equal to the minimum of the 95UCL and the maximum.
Mercury TRV is based on inorganic mercury.

Hazard Quotients (HQs) for the Ingestion of Surface Water
Wildlife Receptor - Masked Shrew

Richardson Flat Tailings
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (ug/L)	Calculated Dose (mg/kg BW/day)	TRV(mg/kg BW/day)		Surface Water HQ	
				NOAEL	LOAEL	NOAEL	LOAEL
Silver Creek - upstream	Arsenic	18	0.0030	0.3	0.8	1E-02	4E-03
	Lead	953	0.1594	0.04	0.1	**4E+00**	1E+00
	Mercury	90.0	0.0151	1.3	4.0	1E-02	4E-03
	Selenium	4.1	0.0007	0.04	0.07	2E-02	1E-02
	Zinc	5,666	0.9473	12	24	8E-02	4E-02
	TOTAL HI					**4E+00**	*1E+00*
Silver Creek - downstream	Arsenic	23.0	0.0038	0.3	0.8	2E-02	5E-03
	Lead	165	0.0276	0.04	0.1	7E-01	2E-01
	Mercury	75.1	0.0126	1.3	4.0	1E-02	3E-03
	Selenium	5.0	0.0008	0.04	0.07	2E-02	1E-02
	Zinc	1,426	0.2385	12	24	2E-02	1E-02
	TOTAL HI					*7E-01*	*3E-01*
South Diversion Ditch	Arsenic	68	0.0114	0.3	0.8	5E-02	2E-02
	Lead	17	0.0029	0.04	0.1	7E-02	2E-02
	Mercury	0.5	0.0001	1.3	4.0	6E-05	2E-05
	Selenium	4.7	0.0008	0.04	0.07	2E-02	1E-02
	Zinc	2,380	0.3979	12	24	3E-02	2E-02
	TOTAL HI					*2E-01*	*7E-02*
Ponded Water	Arsenic	10	0.0017	0.3	0.8	7E-03	2E-03
	Lead	2.5	0.0004	0.04	0.1	1E-02	3E-03
	Mercury	0.3	0.00004	1.3	4.0	3E-05	1E-05
	Selenium	2.5	0.0004	0.04	0.07	1E-02	6E-03
	Zinc	11	0.0018	12	24	2E-04	8E-05
	TOTAL HI					*3E-02*	*1E-02*
Unnamed Drainages	Arsenic	17	0.0028	0.3	0.8	1E-02	4E-03
	Lead	7.0	0.0012	0.04	0.1	3E-02	9E-03
	Mercury	0.2	0.00004	1.3	4.0	3E-05	1E-05
	Selenium	2.0	0.0003	0.04	0.07	8E-03	5E-03
	Zinc	98	0.0164	12	24	1E-03	7E-04
	TOTAL HI					*5E-02*	*2E-02*

NA = Not Available
NC = Not Calculated

HQs greater than 1 are shown in **boldface** type.
EPC is equal to the minimum of the 95UCL and the maximum.
Mercury TRV is based on inorganic mercury.

Hazard Quotients (HQs) for the Ingestion of Surface Water
Wildlife Receptor - Mink

Richardson Flat Tailings
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (ug/L)	Calculated Dose (mg/kg BW/day)	TRV(mg/kg BW/day)		Surface Water HQ	
				NOAEL	LOAEL	NOAEL	LOAEL
Silver Creek - upstream	Arsenic	18	0.0019	0.3	0.8	7E-03	2E-03
	Lead	953	0.1001	0.16	0.3	6E-01	3E-01
	Mercury	90.0	0.0095	0.7	2.1	1E-02	5E-03
	Selenium	4.1	0.0004	0.04	0.07	1E-02	7E-03
	Zinc	5,666	0.5948	156	467	4E-03	1E-03
	TOTAL HI					*7E-01*	*3E-01*
Silver Creek - downstream	Arsenic	23.0	0.0024	0.3	0.8	1E-02	3E-03
	Lead	165	0.0174	0.16	0.3	1E-01	6E-02
	Mercury	75.1	0.0079	0.7	2.1	1E-02	4E-03
	Selenium	5.0	0.0005	0.04	0.07	1E-02	8E-03
	Zinc	1,426	0.1498	156	467	1E-03	3E-04
	TOTAL HI					*1E-01*	*7E-02*
South Diversion Ditch	Arsenic	68	0.0072	0.3	0.8	3E-02	9E-03
	Lead	17	0.0018	0.16	0.3	1E-02	6E-03
	Mercury	0.5	0.0001	0.7	2.1	7E-05	2E-05
	Selenium	4.7	0.0005	0.04	0.07	1E-02	8E-03
	Zinc	2,380	0.2499	156	467	2E-03	5E-04
	TOTAL HI					*5E-02*	*2E-02*
Ponded Water	Arsenic	10	0.0010	0.3	0.8	4E-03	1E-03
	Lead	2.5	0.0003	0.16	0.3	2E-03	9E-04
	Mercury	0.3	0.00003	0.7	2.1	4E-05	1E-05
	Selenium	2.5	0.0003	0.04	0.07	7E-03	4E-03
	Zinc	11	0.0012	156	467	7E-06	2E-06
	TOTAL HI					*1E-02*	*6E-03*
Unnamed Drainages	Arsenic	17	0.0018	0.3	0.8	7E-03	2E-03
	Lead	7.0	0.0007	0.16	0.3	5E-03	2E-03
	Mercury	0.2	0.00003	0.7	2.1	4E-05	1E-05
	Selenium	2.0	0.0002	0.04	0.07	5E-03	3E-03
	Zinc	98	0.0103	156	467	7E-05	2E-05
	TOTAL HI					*2E-02*	*8E-03*

NA = Not Available
NC = Not Calculated

HQs greater than 1 are shown in **boldface** type.
EPC is equal to the minimum of the 95UCL and the maximum.
Mercury TRV is based on inorganic mercury.

Hazard Quotients (HQs) for the Ingestion of Surface Water
Wildlife Receptor - Deer Mice

Richardson Flat Tailings
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (ug/L)	Calculated Dose (mg/kg BW/day)	TRV(mg/kg BW/day)		Surface Water HQ	
				NOAEL	LOAEL	NOAEL	LOAEL
Silver Creek - upstream	Arsenic	18	0.0026	1.3	3.8	2E-03	7E-04
	Lead	953	0.1403	0.21	0.6	7E-01	2E-01
	Mercury	90.0	0.0132	3.3	9.9	4E-03	1E-03
	Selenium	4.1	0.0006	0.07	0.11	9E-03	6E-03
	Zinc	5,666	0.8337	20	40	4E-02	2E-02
	TOTAL HI					*7E-01*	*3E-01*
Silver Creek - downstream	Arsenic	23.0	0.0034	1.3	3.8	3E-03	9E-04
	Lead	165	0.0243	0.21	0.6	1E-01	4E-02
	Mercury	75.1	0.0111	3.3	9.9	3E-03	1E-03
	Selenium	5.0	0.0007	0.07	0.11	1E-02	7E-03
	Zinc	1,426	0.2099	20	40	1E-02	5E-03
	TOTAL HI					*1E-01*	*5E-02*
South Diversion Ditch	Arsenic	68	0.0100	1.3	3.8	8E-03	3E-03
	Lead	17	0.0025	0.21	0.6	1E-02	4E-03
	Mercury	0.5	0.0001	3.3	9.9	2E-05	7E-06
	Selenium	4.7	0.0007	0.07	0.11	1E-02	6E-03
	Zinc	2,380	0.3502	20	40	2E-02	9E-03
	TOTAL HI					*5E-02*	*2E-02*
Ponded Water	Arsenic	10	0.0015	1.3	3.8	1E-03	4E-04
	Lead	2.5	0.0004	0.21	0.6	2E-03	6E-04
	Mercury	0.3	0.00004	3.3	9.9	1E-05	4E-06
	Selenium	2.5	0.0004	0.07	0.11	6E-03	3E-03
	Zinc	11	0.0016	20	40	8E-05	4E-05
	TOTAL HI					*9E-03*	*4E-03*
Unnamed Drainages	Arsenic	17	0.0025	1.3	3.8	2E-03	7E-04
	Lead	7.0	0.0010	0.21	0.6	5E-03	2E-03
	Mercury	0.2	0.00004	3.3	9.9	1E-05	4E-06
	Selenium	2.0	0.0003	0.07	0.11	4E-03	3E-03
	Zinc	98	0.0144	20	40	7E-04	4E-04
	TOTAL HI					*1E-02*	*5E-03*

NA = Not Available
NC = Not Calculated

HQs greater than 1 are shown in **boldface** type.
EPC is equal to the minimum of the 95UCL and the maximum.
Mercury TRV is based on inorganic mercury.

Hazard Quotients (HQs) for the Incidental Ingestion of Sediment
Wildlife Receptor - Belted Kingfisher

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (mg/kg)	Calculated Dose (mg/kg BW/day)	NOAEL TRV (mg/kg BW/day)	LOAEL TRV (mg/kg BW/day)	Sediment Ingestion HQ	
						NOAEL	LOAEL
Upstream Silver Creek	Aluminum	15,220	20.4072	7.0	35	**3E+00**	6E-01
	Antimony	889	1.1920	NA	NA	NC	NC
	Arsenic	1,735	2.3263	0.8	7.1	**3E+00**	3E-01
	Barium	NA	NA	2.8	5.6	NC	NC
	Cadmium	179	0.2400	0.09	2.4	**3E+00**	1E-01
	Chromium	42	0.0563	0.2	1.0	3E-01	6E-02
	Cobalt	NA	NA	0.3	0.5	NC	NC
	Copper	2,559	3.4311	4.0	6.0	9E-01	6E-01
	Lead	42,990	57.6417	0.9	1.8	**7E+01**	**3E+01**
	Manganese	NA	NA	65	195	NC	NC
	Mercury	1.6	0.0021	0.09	0.18	2E-02	1E-02
	Nickel	NA	NA	5.2	15	NC	NC
	Selenium	32	0.0429	0.100	0.20	4E-01	2E-01
	Thallium	NA	NA	NA	NA	NC	NC
	Vanadium	NA	NA	2.3	6.8	NC	NC
	Zinc	**44,560**	**59.7468**	**26**	**79**	**2E+00**	**8E-01**
	TOTAL HI					**8E+01**	**4E+01**
Downstream Silver Creek	Aluminum	11,590	15.5401	7.0	35	**2E+00**	4E-01
	Antimony	140	0.1877	NA	NA	NC	NC
	Arsenic	341	0.4572	0.8	7.1	6E-01	6E-02
	Barium	NA	NA	2.8	5.6	NC	NC
	Cadmium	58	0.0778	0.09	2.4	9E-01	3E-02
	Chromium	32	0.0429	0.2	1.0	2E-01	4E-02
	Cobalt	NA	NA	0.3	0.5	NC	NC
	Copper	766	1.0271	4.0	6.0	3E-01	2E-01
	Lead	11,130	14.9233	0.9	1.8	**2E+01**	**9E+00**
	Manganese	NA	NA	65	195	NC	NC
	Mercury	0.44	0.0006	0.09	0.18	7E-03	3E-03
	Nickel	NA	NA	5.2	15	NC	NC
	Selenium	11	0.0147	0.100	0.20	1E-01	7E-02
	Thallium	NA	NA	NA	NA	NC	NC
	Vanadium	NA	NA	2.3	6.8	NC	NC
	Zinc	**11,950**	**16.0228**	**26**	**79**	**6E-01**	**2E-01**
	TOTAL HI					**2E+01**	**1E+01**
South Diversion Ditch	Aluminum	15,125	20.2804	7.0	35	**3E+00**	6E-01
	Antimony	93	0.1245	NA	NA	NC	NC
	Arsenic	163	0.2184	0.8	7.1	3E-01	3E-02
	Barium	NA	NA	2.8	5.6	NC	NC
	Cadmium	66.2	0.0887	0.09	2.4	1E+00	4E-02
	Chromium	23.5	0.0315	0.2	1.0	2E-01	3E-02
	Cobalt	NA	NA	0.3	0.5	NC	NC
	Copper	270	0.3615	4.0	6.0	9E-02	6E-02
	Lead	3,042	4.0786	0.9	1.8	**5E+00**	**2E+00**
	Manganese	NA	NA	65	195	NC	NC
	Mercury	1.6	0.0021	0.09	0.18	2E-02	1E-02
	Nickel	NA	NA	5.2	15	NC	NC
	Selenium	7.0	0.0094	0.100	0.20	9E-02	5E-02
	Thallium	NA	NA	NA	NA	NC	NC
	Vanadium	NA	NA	2.3	6.8	NC	NC
	Zinc	**12,000**	**16.0898**	**26**	**79**	**6E-01**	**2E-01**
	TOTAL HI					**1E+01**	**3E+00**
Wetlands Area	Aluminum	28,800	38.6155	7.0	35	**6E+00**	1E+00
	Antimony	99	0.1327	NA	NA	NC	NC
	Arsenic	299.8	0.4019	0.8	7.1	5E-01	6E-02
	Barium	562	0.7535	2.8	5.6	3E-01	1E-01
	Cadmium	93.1	0.1248	0.09	2.4	1E+00	5E-02
	Chromium	62.4	0.0837	0.2	1.0	4E-01	8E-02
	Cobalt	20	0.0268	0.3	0.5	1E-01	5E-02
	Copper	725	0.9721	4.0	6.0	2E-01	2E-01
	Lead	6,520	8.7421	0.9	1.8	**1E+01**	**5E+00**
	Manganese	42,000	56.3143	65	195	9E-01	3E-01
	Mercury	8.2	0.0110	0.09	0.18	1E-01	6E-02
	Nickel	97.2	0.1303	5.2	15	3E-02	8E-03
	Selenium	43.1	0.0578	0.100	0.20	6E-01	3E-01
	Thallium	12.16	0.0163	NA	NA	NC	NC
	Vanadium	70.6	0.0947	2.3	6.8	4E-02	1E-02
	Zinc	**15,200**	**20.3804**	**26**	**79**	**8E-01**	**3E-01**
	TOTAL HI					**2E+01**	**8E+00**

NA = Not Available
NC = Not Calculated

HQs greater than one are shown in **boldface** type.
EPC is equal to the minimum of the 95UCL and the maximum.
Mercury TRV is based on inorganic mercury.

Hazard Quotients (HQs) for the Incidental Ingestion of Sediment
Wildlife Receptor - Mallard Duck

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (mg/kg)	Calculated Dose (mg/kg BW/day)	NOAEL TRV (mg/kg BW/day)	LOAEL TRV (mg/kg BW/day)	Sediment Ingestion HQ	
						NOAEL	LOAEL
Upstream Silver Creek	Aluminum	15,220	20.2829	7.0	35	**3E+00**	6E-01
	Antimony	889	1.1847	NA	NA	NC	NC
	Arsenic	1,735	2.3121	0.8	7.1	**3E+00**	3E-01
	Barium	NA	NA	2.8	5.6	NC	NC
	Cadmium	179	0.2385	0.09	2.4	**3E+00**	1E-01
	Chromium	42	0.0560	0.2	1.0	3E-01	6E-02
	Cobalt	NA	NA	0.3	0.5	NC	NC
	Copper	2,559	3.4102	4.0	6.0	8E-01	6E-01
	Lead	42,990	57.2905	0.9	1.8	**7E+01**	**3E+01**
	Manganese	NA	NA	65	195	NC	NC
	Mercury	1.6	0.0021	0.09	0.18	2E-02	1E-02
	Nickel	NA	NA	5.2	15	NC	NC
	Selenium	32	0.0426	0.100	0.20	4E-01	2E-01
	Thallium	NA	NA	NA	NA	NC	NC
	Vanadium	NA	NA	2.3	6.8	NC	NC
	Zinc	**44,560**	**59.3827**	**26**	**79**	**2E+00**	**8E-01**
	TOTAL HI					**8E+01**	**4E+01**
Downstream Silver Creek	Aluminum	11,590	15.4454	7.0	35	**2E+00**	4E-01
	Antimony	140	0.1866	NA	NA	NC	NC
	Arsenic	341	0.4544	0.8	7.1	6E-01	6E-02
	Barium	NA	NA	2.8	5.6	NC	NC
	Cadmium	58	0.0773	0.09	2.4	9E-01	3E-02
	Chromium	32	0.0426	0.2	1.0	2E-01	4E-02
	Cobalt	NA	NA	0.3	0.5	NC	NC
	Copper	766	1.0208	4.0	6.0	3E-01	2E-01
	Lead	11,130	14.8324	0.9	1.8	**2E+01**	**8E+00**
	Manganese	NA	NA	65	195	NC	NC
	Mercury	0.44	0.0006	0.09	0.18	6E-03	3E-03
	Nickel	NA	NA	5.2	15	NC	NC
	Selenium	11	0.0147	0.100	0.20	1E-01	7E-02
	Thallium	NA	NA	NA	NA	NC	NC
	Vanadium	NA	NA	2.3	6.8	NC	NC
	Zinc	**11,950**	**15.9251**	**26**	**79**	**6E-01**	**2E-01**
	TOTAL HI					**2E+01**	**1E+01**
South Diversion Ditch	Aluminum	15,125	20.1569	7.0	35	**3E+00**	6E-01
	Antimony	93	0.1238	NA	NA	NC	NC
	Arsenic	163	0.2171	0.8	7.1	3E-01	3E-02
	Barium	NA	NA	2.8	5.6	NC	NC
	Cadmium	66.2	0.0882	0.09	2.4	1E+00	4E-02
	Chromium	23.5	0.0313	0.2	1.0	2E-01	3E-02
	Cobalt	NA	NA	0.3	0.5	NC	NC
	Copper	270	0.3593	4.0	6.0	9E-02	6E-02
	Lead	3,042	4.0538	0.9	1.8	**5E+00**	**2E+00**
	Manganese	NA	NA	65	195	NC	NC
	Mercury	1.6	0.0021	0.09	0.18	2E-02	1E-02
	Nickel	NA	NA	5.2	15	NC	NC
	Selenium	7.0	0.0093	0.100	0.20	9E-02	5E-02
	Thallium	NA	NA	NA	NA	NC	NC
	Vanadium	NA	NA	2.3	6.8	NC	NC
	Zinc	**12,000**	**15.9918**	**26**	**79**	**6E-01**	**2E-01**
	TOTAL HI					**1E+01**	**3E+00**
Wetlands Area	Aluminum	28,800	38.3802	7.0	35	**5E+00**	1E+00
	Antimony	99	0.1319	NA	NA	NC	NC
	Arsenic	299.8	0.3995	0.8	7.1	5E-01	6E-02
	Barium	562	0.7489	2.8	5.6	3E-01	1E-01
	Cadmium	93.1	0.1241	0.09	2.4	1E+00	5E-02
	Chromium	62.4	0.0832	0.2	1.0	4E-01	8E-02
	Cobalt	20	0.0267	0.3	0.5	1E-01	5E-02
	Copper	725	0.9662	4.0	6.0	2E-01	2E-01
	Lead	6,520	8.6889	0.9	1.8	**1E+01**	**5E+00**
	Manganese	42,000	55.9712	65	195	9E-01	3E-01
	Mercury	8.2	0.0109	0.09	0.18	1E-01	6E-02
	Nickel	97.2	0.1295	5.2	15	3E-02	8E-03
	Selenium	43.1	0.0574	0.100	0.20	6E-01	3E-01
	Thallium	12.16	0.0162	NA	NA	NC	NC
	Vanadium	70.6	0.0941	2.3	6.8	4E-02	1E-02
	Zinc	**15,200**	**20.2562**	**26**	**79**	**8E-01**	**3E-01**
	TOTAL HI					**2E+01**	**8E+00**

NA = Not Available
NC = Not Calculated

HQs greater than one are shown in **boldface** type.
EPC is equal to the minimum of the 95UCL and the maximum.
Mercury TRV is based on inorganic mercury.

Hazard Quotients (HQs) for the Incidental Ingestion of Sediment
Wildlife Receptor - Mink

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (mg/kg)	Calculated Dose (mg/kg BW/day)	NOAEL TRV (mg/kg BW/day)	LOAEL TRV (mg/kg BW/day)	Sediment Ingestion HQ	
						NOAEL	LOAEL
Upstream Silver Creek	Aluminum	15,220	6.0907	1.4	7	**4E+00**	9E-01
	Antimony	889	0.3558	0.01	0.02	**6E+01**	**2E+01**
	Arsenic	1,735	0.6943	0.2	0.5	**5E+00**	**2E+00**
	Barium	NA	NA	2.0	6.1	NC	NC
	Cadmium	179	0.0716	0.50	1.0	1E-01	7E-02
	Chromium	42	0.0168	800	2400.0	2E-05	7E-06
	Cobalt	NA	NA	1.3	4.0	NC	NC
	Copper	2,559	1.0241	8.8	12.8	1E-01	8E-02
	Lead	42,990	17.2037	0.3	0.6	**6E+01**	**3E+01**
	Manganese	NA	NA	18	57	NC	NC
	Mercury	1.6	0.0006	1.37	4.11	5E-04	2E-04
	Nickel	NA	NA	8.0	24	NC	NC
	Selenium	32	0.0128	0.079	0.13	2E-01	1E-01
	Thallium	NA	NA	0.002	0.01	NC	NC
	Vanadium	NA	NA	0.7	2.0	NC	NC
	Zinc	**44,560**	**17.8320**	**311**	**933**	**6E-02**	**2E-02**
	TOTAL HI					**1E+02**	**5E+01**
Downstream Silver Creek	Aluminum	11,590	4.6381	1.4	7	**3E+00**	7E-01
	Antimony	140	0.0560	0.01	0.02	**9E+00**	**3E+00**
	Arsenic	341	0.1365	0.2	0.5	9E-01	3E-01
	Barium	NA	NA	2.0	6.1	NC	NC
	Cadmium	58	0.0232	0.50	1.0	5E-02	2E-02
	Chromium	32	0.0128	800	2400.0	2E-05	5E-06
	Cobalt	NA	NA	1.3	4.0	NC	NC
	Copper	766	0.3065	8.8	12.8	3E-02	2E-02
	Lead	11,130	4.4540	0.3	0.6	**1E+01**	**7E+00**
	Manganese	NA	NA	18	57	NC	NC
	Mercury	0.44	0.0002	1.37	4.11	1E-04	4E-05
	Nickel	NA	NA	8.0	24	NC	NC
	Selenium	11	0.0044	0.079	0.13	6E-02	3E-02
	Thallium	NA	NA	0.002	0.01	NC	NC
	Vanadium	NA	NA	0.7	2.0	NC	NC
	Zinc	**11,950**	**4.7821**	**311**	**933**	**2E-02**	**5E-03**
	TOTAL HI					**3E+01**	**1E+01**
South Diversion Ditch	Aluminum	15,125	6.0529	1.4	7	**4E+00**	9E-01
	Antimony	93	0.0372	0.01	0.02	**6E+00**	**2E+00**
	Arsenic	163	0.0652	0.2	0.5	4E-01	1E-01
	Barium	NA	NA	2.0	6.1	NC	NC
	Cadmium	66.2	0.0265	0.50	1.0	5E-02	3E-02
	Chromium	23.5	0.0094	800	2400.0	1E-05	4E-06
	Cobalt	NA	NA	1.3	4.0	NC	NC
	Copper	270	0.1079	8.8	12.8	1E-02	8E-03
	Lead	3,042	1.2173	0.3	0.6	**4E+00**	**2E+00**
	Manganese	NA	NA	18	57	NC	NC
	Mercury	1.6	0.0006	1.37	4.11	5E-04	2E-04
	Nickel	NA	NA	8.0	24	NC	NC
	Selenium	7.0	0.0028	0.079	0.13	4E-02	2E-02
	Thallium	NA	NA	0.002	0.01	NC	NC
	Vanadium	NA	NA	0.7	2.0	NC	NC
	Zinc	**12,000**	**4.8022**	**311**	**933**	**2E-02**	**5E-03**
	TOTAL HI					**1E+01**	**5E+00**
Wetlands Area	Aluminum	28,800	11.5252	1.4	7	**8E+00**	**2E+00**
	Antimony	99	0.0396	0.01	0.02	**6E+00**	**2E+00**
	Arsenic	299.8	0.1200	0.2	0.5	8E-01	3E-01
	Barium	562	0.2249	2.0	6.1	1E-01	4E-02
	Cadmium	93.1	0.0373	0.50	1.0	8E-02	4E-02
	Chromium	62.4	0.0250	800	2400.0	3E-05	1E-05
	Cobalt	20	0.0080	1.3	4.0	6E-03	2E-03
	Copper	725	0.2901	8.8	12.8	3E-02	2E-02
	Lead	6,520	2.6092	0.3	0.6	**8E+00**	**4E+00**
	Manganese	42,000	16.8076	18	57	1E+00	3E-01
	Mercury	8.2	0.0033	1.37	4.11	2E-03	8E-04
	Nickel	97.2	0.0389	8.0	24	5E-03	2E-03
	Selenium	43.1	0.0172	0.079	0.13	2E-01	1E-01
	Thallium	12.16	0.0049	0.002	0.01	**2E+00**	8E-01
	Vanadium	70.6	0.0283	0.7	2.0	4E-02	1E-02
	Zinc	**15,200**	**6.0827**	**311**	**933**	**2E-02**	**7E-03**
	TOTAL HI					**3E+01**	**1E+01**

NA = Not Available
NC = Not Calculated

HQs greater than one are shown in boldface type.
EPC is equal to the minimum of the 95UCL and the maximum.
Mercury TRV is based on inorganic mercury.

Hazard Quotients (HQs) for the Ingestion of Seep Water*
Wildlife Receptor - Greater-Sage Grouse

Richardson Flat Tailings

Screening Ecological Risk Assessment

Designated Reach	Parameter	Max Exposure Concentration (ug/L)	Calculated Dose (mg/kg BW/day)	TRV(mg/kg BW/day)		Seep Water HQ	
				NOAEL	LOAEL	NOAEL	LOAEL
Monitoring wells below main embankment	Arsenic	349	0.15643	0.4	3.5	4E-01	4E-02
	Lead	96	0.04296	0.44	0.9	1E-01	5E-02
	Mercury	0.7	0.00031	0.0	0.1	7E-03	3E-03
	Selenium	15	0.00672	0.10	0.10	7E-02	7E-02
	Zinc	2,790	1.25051	13	39	1E-01	3E-02
	TOTAL HI					*7E-01*	*2E-01*
Upgradient monitoring well	Arsenic	3.7	0.00166	0.4	3.5	4E-03	5E-04
	Lead	627	0.28103	0.44	0.9	6E-01	3E-01
	Mercury	0.20	0.00009	0.0	0.1	2E-03	1E-03
	Selenium	3.0	0.00134	0.10	0.10	1E-02	1E-02
	Zinc	136	0.06096	13	39	5E-03	2E-03
	TOTAL HI					*7E-01*	*3E-01*

NA = Not Available
NC = Not Calculated

HQs greater than 1 are shown in **boldface** type.
***Seep concentrations are estimated using available groundwater data.**
Mercury TRV is based on inorganic mercury.

Hazard Quotients (HQs) for the Ingestion of Seep Water*
Wildlife Receptor - Mallard Duck

Richardson Flat Tailings

Screening Ecological Risk Assessment

Designated Reach	Parameter	Max Exposure Concentration (ug/L)	Calculated Dose (mg/kg BW/day)	TRV(mg/kg BW/day)		Seep Water HQ	
				NOAEL	LOAEL	NOAEL	LOAEL
Monitoring wells below main embankment	Arsenic	349	0.01975	0.4	3.5	5E-02	6E-03
	Lead	96	0.00543	0.44	0.9	1E-02	6E-03
	Mercury	0.7	0.00004	0.0	0.1	9E-04	4E-04
	Selenium	15	0.00085	0.10	0.10	8E-03	8E-03
	Zinc	2,790	0.15792	13	39	1E-02	4E-03
	TOTAL HI					*8E-02*	*2E-02*
Upgradient monitoring well	Arsenic	3.7	0.00021	0.4	3.5	5E-04	6E-05
	Lead	627	0.03549	0.44	0.9	8E-02	4E-02
	Mercury	0.20	0.00001	0.0	0.1	3E-04	1E-04
	Selenium	3.0	0.00017	0.10	0.10	2E-03	2E-03
	Zinc	136	0.00770	13	39	6E-04	2E-04
	TOTAL HI					*8E-02*	*4E-02*

NA = Not Available
NC = Not Calculated

HQs greater than 1 are shown in **boldface** type.
***Seep concentrations are estimated using available groundwater data.**
Mercury TRV is based on inorganic mercury.

Hazard Quotients (HQs) for the Ingestion of Seep Water*
Wildlife Receptor - Belted Kingfisher

Richardson Flat Tailings

Screening Ecological Risk Assessment

Designated Reach	Parameter	Max Exposure Concentration (ug/L)	Calculated Dose (mg/kg BW/day)	TRV(mg/kg BW/day)		Seep Water HQ	
				NOAEL	LOAEL	NOAEL	LOAEL
Monitoring wells below main embankment	Arsenic	349	0.03870	0.4	3.5	1E-01	1E-02
	Lead	96	0.01063	0.44	0.9	2E-02	1E-02
	Mercury	0.7	0.00008	0.0	0.1	2E-03	9E-04
	Selenium	15	0.00166	0.10	0.10	2E-02	2E-02
	Zinc	2,790	0.30937	13	39	2E-02	8E-03
	TOTAL HI					*2E-01*	*5E-02*
Upgradient monitoring well	Arsenic	3.7	0.00041	0.4	3.5	1E-03	1E-04
	Lead	627	0.06952	0.44	0.9	2E-01	8E-02
	Mercury	0.20	0.00002	0.0	0.1	5E-04	2E-04
	Selenium	3.0	0.00033	0.10	0.10	3E-03	3E-03
	Zinc	136	0.01508	13	39	1E-03	4E-04
	TOTAL HI					*2E-01*	*8E-02*

NA = Not Available
NC = Not Calculated

HQs greater than 1 are shown in **boldface** type.
***Seep concentrations are estimated using available groundwater data.**
Mercury TRV is based on inorganic mercury.

Hazard Quotients (HQs) for the Ingestion of Seep Water*
Wildlife Receptor - American Robin

Richardson Flat Tailings

Screening Ecological Risk Assessment

Designated Reach	Parameter	Max Exposure Concentration (ug/L)	Calculated Dose (mg/kg BW/day)	TRV(mg/kg BW/day)		Seep Water HQ	
				NOAEL	LOAEL	NOAEL	LOAEL
Monitoring wells below main embankment	Arsenic	349	0.04712	0.4	3.5	1E-01	1E-02
	Lead	96	0.01294	0.44	0.9	3E-02	1E-02
	Mercury	0.7	0.00009	0.0	0.1	2E-03	1E-03
	Selenium	15	0.00203	0.10	0.10	2E-02	2E-02
	Zinc	2,790	0.37668	13	39	3E-02	1E-02
	TOTAL HI					*2E-01*	*6E-02*
Upgradient monitoring well	Arsenic	3.7	0.00050	0.4	3.5	1E-03	1E-04
	Lead	627	0.08465	0.44	0.9	2E-01	1E-01
	Mercury	0.20	0.00003	0.0	0.1	6E-04	3E-04
	Selenium	3.0	0.00041	0.10	0.10	4E-03	4E-03
	Zinc	136	0.01836	13	39	1E-03	5E-04
	TOTAL HI					*2E-01*	*1E-01*

NA = Not Available
NC = Not Calculated

HQs greater than 1 are shown in **boldface** type.
***Seep concentrations are estimated using available groundwater data.**
Mercury TRV is based on inorganic mercury.

Hazard Quotients (HQs) for the Ingestion of Seep Water*
Wildlife Receptor - American Kestrel

Richardson Flat Tailings

Screening Ecological Risk Assessment

Designated Reach	Parameter	Max Exposure Concentration (ug/L)	Calculated Dose (mg/kg BW/day)	TRV(mg/kg BW/day)		Seep Water HQ	
				NOAEL	LOAEL	NOAEL	LOAEL
Monitoring wells below main embankment	Arsenic	349	0.04204	0.4	3.5	1E-01	1E-02
	Lead	96	0.01155	0.44	0.9	3E-02	1E-02
	Mercury	0.7	0.00008	0.0	0.1	2E-03	9E-04
	Selenium	15	0.00181	0.10	0.10	2E-02	2E-02
	Zinc	2,790	0.33607	13	39	3E-02	9E-03
	TOTAL HI					*2E-01*	*5E-02*
Upgradient monitoring well	Arsenic	3.7	0.00045	0.4	3.5	1E-03	1E-04
	Lead	627	0.07552	0.44	0.9	2E-01	9E-02
	Mercury	0.20	0.00002	0.0	0.1	5E-04	3E-04
	Selenium	3.0	0.00036	0.10	0.10	4E-03	4E-03
	Zinc	136	0.01638	13	39	1E-03	4E-04
	TOTAL HI					*2E-01*	*9E-02*

NA = Not Available
NC = Not Calculated

HQs greater than 1 are shown in **boldface** type.
***Seep concentrations are estimated using available groundwater data.**
Mercury TRV is based on inorganic mercury.

Hazard Quotients (HQs) for the Ingestion of Seep Water*
Wildlife Receptor - Red Fox

Richardson Flat Tailings

Screening Ecological Risk Assessment

Designated Reach	Parameter	Max Exposure Concentration (ug/L)	Calculated Dose (mg/kg BW/day)	TRV(mg/kg BW/day)		Seep Water HQ	
				NOAEL	LOAEL	NOAEL	LOAEL
Monitoring wells below main embankment	Arsenic	349	0.02970	0.3	0.8	1E-01	4E-02
	Lead	96	0.00816	0.21	0.4	4E-02	2E-02
	Mercury	0.7	0.00006	0.2	0.5	3E-04	1E-04
	Selenium	15	0.00128	0.07	0.07	2E-02	2E-02
	Zinc	2,790	0.23743	39	117	6E-03	2E-03
	TOTAL HI					*2E-01*	*8E-02*
Upgradient monitoring well	Arsenic	3.7	0.00031	0.3	0.8	1E-03	4E-04
	Lead	627	0.05336	0.21	0.4	3E-01	1E-01
	Mercury	0.20	0.00002	0.2	0.5	1E-04	3E-05
	Selenium	3.0	0.00026	0.07	0.07	4E-03	4E-03
	Zinc	136	0.01157	39	117	3E-04	1E-04
	TOTAL HI					*3E-01*	*1E-01*

NA = Not Available
NC = Not Calculated

HQs greater than 1 are shown in **boldface** type.
***Seep concentrations are estimated using available groundwater data.**
Mercury TRV is based on inorganic mercury.

Hazard Quotients (HQs) for the Ingestion of Seep Water*
Wildlife Receptor - Masked Shrew

Richardson Flat Tailings

Screening Ecological Risk Assessment

Designated Reach	Parameter	Max Exposure Concentration (ug/L)	Calculated Dose (mg/kg BW/day)	TRV(mg/kg BW/day)		Seep Water HQ	
				NOAEL	LOAEL	NOAEL	LOAEL
Monitoring wells below main embankment	Arsenic	349	0.05835	0.3	0.8	2E-01	8E-02
	Lead	96	0.01602	0.04	0.1	4E-01	1E-01
	Mercury	0.7	0.00012	1.3	4.0	9E-05	3E-05
	Selenium	15	0.00251	0.07	0.07	4E-02	4E-02
	Zinc	2,790	0.46646	12	24	4E-02	2E-02
	TOTAL HI					*7E-01*	*3E-01*
Upgradient monitoring well	Arsenic	3.7	0.00062	0.3	0.8	2E-03	8E-04
	Lead	627	0.10483	0.04	0.1	**3E+00**	8E-01
	Mercury	0.20	0.00003	1.3	4.0	3E-05	8E-06
	Selenium	3.0	0.00050	0.07	0.07	8E-03	8E-03
	Zinc	136	0.02274	12	24	2E-03	9E-04
	TOTAL HI					**3E+00**	*8E-01*

NA = Not Available
NC = Not Calculated

HQs greater than 1 are shown in **boldface** type.
***Seep concentrations are estimated using available groundwater data.**
Mercury TRV is based on inorganic mercury.

Hazard Quotients (HQs) for the Ingestion of Seep Water*
Wildlife Receptor - Mink

Richardson Flat Tailings

Screening Ecological Risk Assessment

Designated Reach	Parameter	Max Exposure Concentration (ug/L)	Calculated Dose (mg/kg BW/day)	TRV(mg/kg BW/day)		Seep Water HQ	
				NOAEL	LOAEL	NOAEL	LOAEL
Monitoring wells below main embankment	Arsenic	349	0.03664	0.3	0.8	1E-01	5E-02
	Lead	96	0.01006	0.16	0.3	6E-02	3E-02
	Mercury	0.7	0.00007	0.7	2.1	1E-04	4E-05
	Selenium	15	0.00157	0.07	0.07	2E-02	2E-02
	Zinc	2,790	0.29291	156	467	2E-03	6E-04
	TOTAL HI					*2E-01*	*1E-01*
Upgradient monitoring well	Arsenic	3.7	0.00039	0.3	0.8	2E-03	5E-04
	Lead	627	0.06583	0.16	0.3	4E-01	2E-01
	Mercury	0.20	0.00002	0.7	2.1	3E-05	1E-05
	Selenium	3.0	0.00031	0.07	0.07	5E-03	5E-03
	Zinc	136	0.01428	156	467	9E-05	3E-05
	TOTAL HI					*4E-01*	*2E-01*

NA = Not Available
NC = Not Calculated

HQs greater than 1 are shown in **boldface** type.
***Seep concentrations are estimated using available groundwater data.**
Mercury TRV is based on inorganic mercury.

Hazard Quotients (HQs) for the Ingestion of Seep Water*
Wildlife Receptor - Deer Mice

Richardson Flat Tailings

Screening Ecological Risk Assessment

Designated Reach	Parameter	Max Exposure Concentration (ug/L)	Calculated Dose (mg/kg BW/day)	TRV(mg/kg BW/day)		Seep Water HQ	
				NOAEL	LOAEL	NOAEL	LOAEL
Monitoring wells below main embankment	Arsenic	349	0.05136	1.3	3.8	4E-02	1E-02
	Lead	96	0.01410	0.21	0.6	7E-02	2E-02
	Mercury	0.7	0.00010	3.3	9.9	3E-05	1E-05
	Selenium	15	0.00221	0.11	0.11	2E-02	2E-02
	Zinc	2,790	0.41055	20	40	2E-02	1E-02
	TOTAL HI					*1E-01*	*7E-02*
Upgradient monitoring well	Arsenic	3.7	0.00054	1.3	3.8	4E-04	1E-04
	Lead	627	0.09226	0.21	0.6	4E-01	1E-01
	Mercury	0.20	0.00003	3.3	9.9	9E-06	3E-06
	Selenium	3.0	0.00044	0.11	0.11	4E-03	4E-03
	Zinc	136	0.02001	20	40	1E-03	5E-04
	TOTAL HI					*4E-01*	*2E-01*

NA = Not Available
NC = Not Calculated

HQs greater than 1 are shown in **boldface** type.
***Seep concentrations are estimated using available groundwater data.**
Mercury TRV is based on inorganic mercury.

Wildlife Hazard Quotients (HQs) for Incidental Ingestion of Soils and Tailings
Wildlife Receptor - American Robin

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (mg/kg)	Calculated Dose (mg/kg BW/day)	NOAEL TRV (mg/kg BW/day)	LOAEL TRV (mg/kg BW/day)	Soil HQ NOAEL	
						NOAEL	LOAEL
Background Soils	Aluminum	NA	NA	7.00	35.00	NC	NC
	Antimony	NA	NA	NA	NA	NC	NC
	Arsenic	10.14	0.150	0.81	7.05	2E-01	2E-02
	Barium	265.00	3.931	2.78	5.55	1E+00	7E-01
	Cadmium	1.00	0.015	0.09	2.39	2E-01	6E-03
	Chromium	23.00	0.341	0.2	1.0	**2E+00**	3E-01
	Copper	29.00	0.430	4.02	6.03	1E-01	7E-02
	Lead	58.67	0.870	0.88	1.75	1E+00	5E-01
	Mercury	0.15	0.002	0.09	0.18	2E-02	1E-02
	Selenium	2.50	0.037	0.20	0.20	2E-01	2E-01
	Zinc	127.00	1.884	26	79	7E-02	2E-02
	TOTAL HI					**5E+00**	**2E+00**
Off-Impoundment Soils	Aluminum	NA	NA	7.00	35.00	NC	NC
	Antimony	NA	NA	NA	NA	NC	NC
	Arsenic	45.43	0.674	0.81	7.05	8E-01	1E-01
	Barium	331.38	4.916	2.78	5.55	**2E+00**	9E-01
	Cadmium	15.30	0.227	0.09	2.39	**3E+00**	9E-02
	Chromium	24.21	0.359	0.2	1.0	**2E+00**	4E-01
	Copper	49.34	0.732	4.02	6.03	2E-01	1E-01
	Lead	883.84	13.111	0.88	1.75	**1E+01**	**7E+00**
	Mercury	1.32	0.020	0.09	0.18	2E-01	1E-01
	Selenium	2.50	0.037	0.20	0.20	2E-01	2E-01
	Zinc	550.85	8.171	2	7	**4E+00**	1E+00
	TOTAL HI					**3E+01**	**1E+01**
On-Impoundment Soils	Aluminum	23738.97	352.150	7.00	35.00	**5E+01**	**1E+01**
	Antimony	4.42	0.066	NA	NA	NC	NC
	Arsenic	24.05	0.357	0.81	7.05	4E-01	5E-02
	Barium	277.01	4.109	2.78	5.55	1E+00	7E-01
	Cadmium	2.03	0.030	0.09	2.39	3E-01	1E-02
	Chromium	24.31	0.361	0.2	1.0	**2E+00**	4E-01
	Copper	41.97	0.623	4.02	6.03	2E-01	1E-01
	Lead	428.97	6.364	0.88	1.75	**7E+00**	**4E+00**
	Mercury	0.32	0.005	0.09	0.18	5E-02	3E-02
	Selenium	2.50	0.037	0.20	0.20	2E-01	2E-01
	Zinc	314.05	4.659	2	7	**2E+00**	7E-01
	TOTAL HI					**6E+01**	**2E+01**
Site Tailings	Aluminum	4257.93	63.163	7.00	35.00	**9E+00**	**2E+00**
	Antimony	195.82	2.905	NA	NA	NC	NC
	Arsenic	298.65	4.430	0.81	7.05	**5E+00**	6E-01
	Barium	NA	NA	2.78	5.55	NC	NC
	Cadmium	43.58	0.646	0.09	2.39	**7E+00**	3E-01
	Chromium	30.53	0.453	0.2	1.0	**2E+00**	5E-01
	Copper	539.46	8.003	4.02	6.03	**2E+00**	1E+00
	Lead	5877.72	87.192	0.88	1.75	**1E+02**	**5E+01**
	Mercury	12.04	0.179	0.09	0.18	**2E+00**	1E+00
	Selenium	14.27	0.212	0.20	0.20	1E+00	1E+00
	Zinc	7544.04	111.910	2	7	**5E+01**	**2E+01**
	TOTAL HI					**2E+02**	**7E+01**

NA = Not Available
NC = Not Calculated

HQs greater than one are shown in boldface type.
EPC is equal to the minimum of the 95UCL and the maximum.
Mercury TRV is based on inorganic mercury.

Wildlife Hazard Quotients (HQs) for Incidental Ingestion of Soils and Tailings
Wildlife Receptor - American Kestrel

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (mg/kg)	Calculated Dose (mg/kg BW/day)	NOAEL TRV (mg/kg BW/day)	LOAEL TRV (mg/kg BW/day)	Soil HQ NOAEL	
						NOAEL	LOAEL
Background Soils	Aluminum	NA	NA	7.00	35.00	NC	NC
	Antimony	NA	NA	NA	NA	NC	NC
	Arsenic	10.14	0.010	0.81	7.05	1E-02	1E-03
	Barium	265.00	0.251	2.78	5.55	9E-02	5E-02
	Cadmium	1.00	0.001	0.09	2.39	1E-02	4E-04
	Chromium	23.00	0.022	0.2	1.0	1E-01	2E-02
	Copper	29.00	0.027	4.02	6.03	7E-03	5E-03
	Lead	58.67	0.056	0.88	1.75	6E-02	3E-02
	Mercury	0.15	0.000	0.09	0.18	2E-03	8E-04
	Selenium	2.50	0.002	0.20	0.20	1E-02	1E-02
	Zinc	127.00	0.120	26	79	5E-03	2E-03
	TOTAL HI					*3E-01*	*1E-01*
Off-Impoundment Soils	Aluminum	NA	NA	7.00	35.00	NC	NC
	Antimony	NA	NA	NA	NA	NC	NC
	Arsenic	45.43	0.043	0.81	7.05	5E-02	6E-03
	Barium	331.38	0.314	2.78	5.55	1E-01	6E-02
	Cadmium	15.30	0.014	0.09	2.39	2E-01	6E-03
	Chromium	24.21	0.023	0.2	1.0	1E-01	2E-02
	Copper	49.34	0.047	4.02	6.03	1E-02	8E-03
	Lead	883.84	0.837	0.88	1.75	1E+00	5E-01
	Mercury	1.32	0.001	0.09	0.18	1E-02	7E-03
	Selenium	2.50	0.002	0.20	0.20	1E-02	1E-02
	Zinc	550.85	0.522	2	7	2E-01	8E-02
	TOTAL HI					**2E+00**	*7E-01*
On-Impoundment Soils	Aluminum	23738.97	22.480	7.00	35.00	**3E+00**	6E-01
	Antimony	4.42	0.004	NA	NA	NC	NC
	Arsenic	24.05	0.023	0.81	7.05	3E-02	3E-03
	Barium	277.01	0.262	2.78	5.55	9E-02	5E-02
	Cadmium	2.03	0.002	0.09	2.39	2E-02	8E-04
	Chromium	24.31	0.023	0.2	1.0	1E-01	2E-02
	Copper	41.97	0.040	4.02	6.03	1E-02	7E-03
	Lead	428.97	0.406	0.88	1.75	5E-01	2E-01
	Mercury	0.32	0.000	0.09	0.18	3E-03	2E-03
	Selenium	2.50	0.002	0.20	0.20	1E-02	1E-02
	Zinc	314.05	0.297	2	7	1E-01	4E-02
	TOTAL HI					**4E+00**	*1E+00*
Site Tailings	Aluminum	4257.93	4.032	7.00	35.00	6E-01	1E-01
	Antimony	195.82	0.185	NA	NA	NC	NC
	Arsenic	298.65	0.283	0.81	7.05	3E-01	4E-02
	Barium	NA	NA	2.78	5.55	NC	NC
	Cadmium	43.58	0.041	0.09	2.39	5E-01	2E-02
	Chromium	30.53	0.029	0.2	1.0	1E-01	3E-02
	Copper	539.46	0.511	4.02	6.03	1E-01	8E-02
	Lead	5877.72	5.566	0.88	1.75	**6E+00**	**3E+00**
	Mercury	12.04	0.011	0.09	0.18	1E-01	6E-02
	Selenium	14.27	0.014	0.20	0.20	7E-02	7E-02
	Zinc	7544.04	7.144	2	7	**3E+00**	1E+00
	TOTAL HI					**1E+01**	**5E+00**

NA = Not Available
NC = Not Calculated

HQs greater than one are shown in boldface type.
EPC is equal to the minimum of the 95UCL and the maximum.
Mercury TRV is based on inorganic mercury.

Wildlife Hazard Quotients (HQs) for Incidental Ingestion of Soils and Tailings
Wildlife Receptor - Red Fox

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (mg/kg)	Calculated Dose (mg/kg BW/day)	NOAEL TRV (mg/kg BW/day)	LOAEL TRV (mg/kg BW/day)	Soil HQ NOAEL	
						NOAEL	LOAEL
Background Soils	Aluminum	NA	NA	1.36	6.61	NC	NC
	Antimony	NA	NA	0.03	0.08	NC	NC
	Arsenic	10.14	0.005	0.20	0.60	3E-02	9E-03
	Barium	265.00	0.137	2.02	6.07	7E-02	2E-02
	Cadmium	1.00	0.001	0.50	0.99	1E-03	5E-04
	Chromium	23.00	0.012	800.0	2400.0	1E-05	5E-06
	Copper	29.00	0.015	2.21	3.21	7E-03	5E-03
	Lead	58.67	0.030	0.42	0.82	7E-02	4E-02
	Mercury	0.15	0.000	0.34	1.03	2E-04	8E-05
	Selenium	2.50	0.001	0.13	0.13	1E-02	1E-02
	Zinc	127.00	0.066	78	233	8E-04	3E-04
	TOTAL HI					*2E-01*	*8E-02*
Off-Impoundment Soils	Aluminum	NA	NA	1.36	6.61	NC	NC
	Antimony	NA	NA	0.03	0.08	NC	NC
	Arsenic	45.43	0.023	0.20	0.60	1E-01	4E-02
	Barium	331.38	0.171	2.02	6.07	8E-02	3E-02
	Cadmium	15.30	0.008	0.50	0.99	2E-02	8E-03
	Chromium	24.21	0.012	800.0	2400.0	2E-05	5E-06
	Copper	49.34	0.025	2.21	3.21	1E-02	8E-03
	Lead	883.84	0.456	0.42	0.82	1E+00	6E-01
	Mercury	1.32	0.001	0.34	1.03	2E-03	7E-04
	Selenium	2.50	0.001	0.13	0.13	1E-02	1E-02
	Zinc	550.85	0.284	1	2	4E-01	1E-01
	TOTAL HI					**2E+00**	*8E-01*
On-Impoundment Soils	Aluminum	23738.97	12.254	1.36	6.61	**9E+00**	**2E+00**
	Antimony	4.42	0.002	0.03	0.08	9E-02	3E-02
	Arsenic	24.05	0.012	0.20	0.60	6E-02	2E-02
	Barium	277.01	0.143	2.02	6.07	7E-02	2E-02
	Cadmium	2.03	0.001	0.50	0.99	2E-03	1E-03
	Chromium	24.31	0.013	800.0	2400.0	2E-05	5E-06
	Copper	41.97	0.022	2.21	3.21	1E-02	7E-03
	Lead	428.97	0.221	0.42	0.82	5E-01	3E-01
	Mercury	0.32	0.000	0.34	1.03	5E-04	2E-04
	Selenium	2.50	0.001	0.13	0.13	1E-02	1E-02
	Zinc	314.05	0.162	1	2	2E-01	8E-02
	TOTAL HI					**1E+01**	**2E+00**
Site Tailings	Aluminum	4257.93	2.198	1.36	6.61	**2E+00**	3E-01
	Antimony	195.82	0.101	0.03	0.08	**4E+00**	1E+00
	Arsenic	298.65	0.154	0.20	0.60	8E-01	3E-01
	Barium	NA	NA	2.02	6.07	NC	NC
	Cadmium	43.58	0.022	0.50	0.99	5E-02	2E-02
	Chromium	30.53	0.016	800.0	2400.0	2E-05	7E-06
	Copper	539.46	0.278	2.21	3.21	1E-01	9E-02
	Lead	5877.72	3.034	0.42	0.82	**7E+00**	**4E+00**
	Mercury	12.04	0.006	0.34	1.03	2E-02	6E-03
	Selenium	14.27	0.007	0.13	0.13	6E-02	6E-02
	Zinc	7544.04	3.894	1	2	**6E+00**	**2E+00**
	TOTAL HI					**2E+01**	**8E+00**

NA = Not Available
NC = Not Calculated

HQs greater than one are shown in boldface type.
EPC is equal to the minimum of the 95UCL and the maximum.
Mercury TRV is based on inorganic mercury.

Wildlife Hazard Quotients (HQs) for Incidental Ingestion of Soils and Tailings
Wildlife Receptor - Masked Shrew

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (mg/kg)	Calculated Dose (mg/kg BW/day)	NOAEL TRV (mg/kg BW/day)	LOAEL TRV (mg/kg BW/day)	Soil HQ NOAEL	
						NOAEL	LOAEL
Background Soils	Aluminum	NA	NA	1.36	6.61	NC	NC
	Antimony	NA	NA	0.01	0.02	NC	NC
	Arsenic	10.14	0.716	0.12	0.36	**6E+00**	**2E+00**
	Barium	265.00	18.720	2.02	6.07	**9E+00**	**3E+00**
	Cadmium	1.00	0.071	0.50	0.99	1E-01	7E-02
	Chromium	23.00	1.625	800.0	2400.0	2E-03	7E-04
	Copper	29.00	2.049	33.60	72.40	6E-02	3E-02
	Lead	58.67	4.144	0.08	0.25	**5E+01**	**2E+01**
	Mercury	0.15	0.011	2.64	7.92	4E-03	1E-03
	Selenium	2.50	0.177	0.13	0.13	1E+00	1E+00
	Zinc	127.00	8.971	24	48	4E-01	2E-01
	TOTAL HI					**7E+01**	**2E+01**
Off-Impoundment Soils	Aluminum	NA	NA	1.36	6.61	NC	NC
	Antimony	NA	NA	0.01	0.02	NC	NC
	Arsenic	45.43	3.209	0.12	0.36	**3E+01**	**9E+00**
	Barium	331.38	23.409	2.02	6.07	**1E+01**	**4E+00**
	Cadmium	15.30	1.081	0.50	0.99	**2E+00**	1E+00
	Chromium	24.21	1.710	800.0	2400.0	2E-03	7E-04
	Copper	49.34	3.486	33.60	72.40	1E-01	5E-02
	Lead	883.84	62.435	0.08	0.25	**7E+02**	**2E+02**
	Mercury	1.32	0.093	2.64	7.92	4E-02	1E-02
	Selenium	2.50	0.177	0.13	0.13	1E+00	1E+00
	Zinc	550.85	38.913	1	2	**6E+01**	**2E+01**
	TOTAL HI					**8E+02**	**3E+02**
On-Impoundment Soils	Aluminum	23738.97	1676.957	1.36	6.61	**1E+03**	**3E+02**
	Antimony	4.42	0.312	0.01	0.02	**5E+01**	**2E+01**
	Arsenic	24.05	1.699	0.12	0.36	**1E+01**	**5E+00**
	Barium	277.01	19.568	2.02	6.07	**1E+01**	**3E+00**
	Cadmium	2.03	0.144	0.50	0.99	3E-01	1E-01
	Chromium	24.31	1.717	800.0	2400.0	2E-03	7E-04
	Copper	41.97	2.965	33.60	72.40	9E-02	4E-02
	Lead	428.97	30.303	0.08	0.25	**4E+02**	**1E+02**
	Mercury	0.32	0.023	2.64	7.92	9E-03	3E-03
	Selenium	2.50	0.177	0.13	0.13	1E+00	1E+00
	Zinc	314.05	22.185	1	2	**3E+01**	**1E+01**
	TOTAL HI					**2E+03**	**4E+02**
Site Tailings	Aluminum	4257.93	300.787	1.36	6.61	**2E+02**	**5E+01**
	Antimony	195.82	13.833	0.01	0.02	**2E+03**	**7E+02**
	Arsenic	298.65	21.097	0.12	0.36	**2E+02**	**6E+01**
	Barium	NA	NA	2.02	6.07	NC	NC
	Cadmium	43.58	3.078	0.50	0.99	**6E+00**	**3E+00**
	Chromium	30.53	2.157	800.0	2400.0	3E-03	9E-04
	Copper	539.46	38.108	33.60	72.40	1E+00	5E-01
	Lead	5877.72	415.211	0.08	0.25	**5E+03**	**2E+03**
	Mercury	12.04	0.850	2.64	7.92	3E-01	1E-01
	Selenium	14.27	1.008	0.13	0.13	**8E+00**	**8E+00**
	Zinc	7544.04	532.922	1	2	**8E+02**	**3E+02**
	TOTAL HI					**8E+03**	**3E+03**

NA = Not Available
NC = Not Calculated

HQs greater than one are shown in boldface type.
EPC is equal to the minimum of the 95UCL and the maximum.
Mercury TRV is based on inorganic mercury.

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Wildlife Hazard Quotients (HQs) for Incidental Ingestion of Soils and Tailings
Wildlife Receptor - Deer Mice

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (mg/kg)	Calculated Dose (mg/kg BW/day)	NOAEL TRV (mg/kg BW/day)	LOAEL TRV (mg/kg BW/day)	Soil HQ NOAEL	
						NOAEL	LOAEL
Background Soils	Aluminum	NA	NA	2.27	11.01	NC	NC
	Antimony	NA	NA	0.03	0.08	NC	NC
	Arsenic	10.14	0.029	2.53	7.59	1E-02	4E-03
	Barium	265.00	0.767	3.37	10.11	2E-01	8E-02
	Cadmium	1.00	0.003	0.83	1.65	4E-03	2E-03
	Chromium	23.00	0.067	1333.3	4000.0	5E-05	2E-05
	Copper	29.00	0.084	168.00	362.00	5E-04	2E-04
	Lead	58.67	0.170	0.42	1.25	4E-01	1E-01
	Mercury	0.15	0.000	6.60	19.80	7E-05	2E-05
	Selenium	2.50	0.007	0.22	0.22	3E-02	3E-02
	Zinc	127.00	0.368	40	80	9E-03	5E-03
	TOTAL HI					*7E-01*	*3E-01*
Off-Impoundment Soils	Aluminum	NA	NA	2.27	11.01	NC	NC
	Antimony	NA	NA	0.03	0.08	NC	NC
	Arsenic	45.43	0.132	2.53	7.59	5E-02	2E-02
	Barium	331.38	0.959	3.37	10.11	3E-01	9E-02
	Cadmium	15.30	0.044	0.83	1.65	5E-02	3E-02
	Chromium	24.21	0.070	1333.3	4000.0	5E-05	2E-05
	Copper	49.34	0.143	168.00	362.00	9E-04	4E-04
	Lead	883.84	2.558	0.42	1.25	**6E+00**	**2E+00**
	Mercury	1.32	0.004	6.60	19.80	6E-04	2E-04
	Selenium	2.50	0.007	0.22	0.22	3E-02	3E-02
	Zinc	550.85	1.595	1	3	1E+00	5E-01
	TOTAL HI					**8E+00**	**3E+00**
On-Impoundment Soils	Aluminum	23738.97	68.718	2.27	11.01	**3E+01**	**6E+00**
	Antimony	4.42	0.013	0.03	0.08	5E-01	2E-01
	Arsenic	24.05	0.070	2.53	7.59	3E-02	9E-03
	Barium	277.01	0.802	3.37	10.11	2E-01	8E-02
	Cadmium	2.03	0.006	0.83	1.65	7E-03	4E-03
	Chromium	24.31	0.070	1333.3	4000.0	5E-05	2E-05
	Copper	41.97	0.122	168.00	362.00	7E-04	3E-04
	Lead	428.97	1.242	0.42	1.25	**3E+00**	1E+00
	Mercury	0.32	0.001	6.60	19.80	1E-04	5E-05
	Selenium	2.50	0.007	0.22	0.22	3E-02	3E-02
	Zinc	314.05	0.909	1	3	8E-01	3E-01
	TOTAL HI					**3E+01**	**8E+00**
Site Tailings	Aluminum	4257.93	12.326	2.27	11.01	**5E+00**	1E+00
	Antimony	195.82	0.567	0.03	0.08	**2E+01**	**8E+00**
	Arsenic	298.65	0.865	2.53	7.59	3E-01	1E-01
	Barium	NA	NA	3.37	10.11	NC	NC
	Cadmium	43.58	0.126	0.83	1.65	2E-01	8E-02
	Chromium	30.53	0.088	1333.3	4000.0	7E-05	2E-05
	Copper	539.46	1.562	168.00	362.00	9E-03	4E-03
	Lead	5877.72	17.014	0.42	1.25	**4E+01**	**1E+01**
	Mercury	12.04	0.035	6.60	19.80	5E-03	2E-03
	Selenium	14.27	0.041	0.22	0.22	2E-01	2E-01
	Zinc	7544.04	21.838	1	3	**2E+01**	**7E+00**
	TOTAL HI					**9E+01**	**3E+01**

NA = Not Available
NC = Not Calculated

HQs greater than one are shown in boldface type.
EPC is equal to the minimum of the 95UCL and the maximum.
Mercury TRV is based on inorganic mercury.

Wildlife Hazard Quotients (HQs) for Incidental Ingestion of Soils and Tailings
Wildlife Receptor - Greater-Sage Grouse

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (mg/kg)	Calculated Dose (mg/kg BW/day)	NOAEL TRV (mg/kg BW/day)	LOAEL TRV (mg/kg BW/day)	Soil HQ NOAEL	
						NOAEL	LOAEL
Background Soils	Aluminum	NA	NA	7.00	35.00	NC	NC
	Antimony	NA	NA	NA	NA	NC	NC
	Arsenic	10.14	0.003	0.81	7.05	4E-03	4E-04
	Barium	265.00	0.076	2.78	5.55	3E-02	1E-02
	Cadmium	1.00	0.000	0.09	2.39	3E-03	1E-04
	Chromium	23.00	0.007	0.2	1.0	3E-02	7E-03
	Copper	29.00	0.008	4.02	6.03	2E-03	1E-03
	Lead	58.67	0.017	0.88	1.75	2E-02	1E-02
	Mercury	0.15	0.000	0.09	0.18	5E-04	2E-04
	Selenium	2.50	0.001	0.20	0.20	4E-03	4E-03
	Zinc	127.00	0.036	26	79	1E-03	5E-04
	TOTAL HI					*9E-02*	*4E-02*
Off-Impoundment Soils	Aluminum	NA	NA	7.00	35.00	NC	NC
	Antimony	NA	NA	NA	NA	NC	NC
	Arsenic	45.43	0.013	0.81	7.05	2E-02	2E-03
	Barium	331.38	0.095	2.78	5.55	3E-02	2E-02
	Cadmium	15.30	0.004	0.09	2.39	5E-02	2E-03
	Chromium	24.21	0.007	0.2	1.0	3E-02	7E-03
	Copper	49.34	0.014	4.02	6.03	4E-03	2E-03
	Lead	883.84	0.254	0.88	1.75	3E-01	1E-01
	Mercury	1.32	0.000	0.09	0.18	4E-03	2E-03
	Selenium	2.50	0.001	0.20	0.20	4E-03	4E-03
	Zinc	550.85	0.158	2	7	7E-02	2E-02
	TOTAL HI					*5E-01*	*2E-01*
On-Impoundment Soils	Aluminum	23738.97	6.812	7.00	35.00	1E+00	2E-01
	Antimony	4.42	0.001	NA	NA	NC	NC
	Arsenic	24.05	0.007	0.81	7.05	8E-03	1E-03
	Barium	277.01	0.079	2.78	5.55	3E-02	1E-02
	Cadmium	2.03	0.001	0.09	2.39	7E-03	2E-04
	Chromium	24.31	0.007	0.2	1.0	3E-02	7E-03
	Copper	41.97	0.012	4.02	6.03	3E-03	2E-03
	Lead	428.97	0.123	0.88	1.75	1E-01	7E-02
	Mercury	0.32	0.000	0.09	0.18	1E-03	5E-04
	Selenium	2.50	0.001	0.20	0.20	4E-03	4E-03
	Zinc	314.05	0.090	2	7	4E-02	1E-02
	TOTAL HI					*1E+00*	*3E-01*
Site Tailings	Aluminum	4257.93	1.222	7.00	35.00	2E-01	3E-02
	Antimony	195.82	0.056	NA	NA	NC	NC
	Arsenic	298.65	0.086	0.81	7.05	1E-01	1E-02
	Barium	NA	NA	2.78	5.55	NC	NC
	Cadmium	43.58	0.013	0.09	2.39	1E-01	5E-03
	Chromium	30.53	0.009	0.2	1.0	4E-02	9E-03
	Copper	539.46	0.155	4.02	6.03	4E-02	3E-02
	Lead	5877.72	1.687	0.88	1.75	**2E+00**	1E+00
	Mercury	12.04	0.003	0.09	0.18	4E-02	2E-02
	Selenium	14.27	0.004	0.20	0.20	2E-02	2E-02
	Zinc	7544.04	2.165	2	7	1E+00	3E-01
	TOTAL HI					**3E+00**	*1E+00*

NA = Not Available
NC = Not Calculated

HQs greater than one are shown in boldface type.
EPC is equal to the minimum of the 95UCL and the maximum.
Mercury TRV is based on inorganic mercury.

Wildlife Hazard Quotients (HQs) for Ingestion of Terrestrial Plants
Wildlife Receptor - Deer Mice

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (mg/kg ww)	Calculated Dose (mg/kg BW/day)	NOAEL TRV (mg/kg BW/day)	LOAEL TRV (mg/kg BW/day)	Plant Ingestion HQ NOAEL	Plant Ingestion HQ LOAEL
Background Soils	Arsenic	0.27	0.070	2.5	7.6	3E-02	9E-03
	Cadmium	0.33	0.087	0.8	1.7	1E-01	5E-02
	Copper	3.90	1.026	168	362	6E-03	3E-03
	Lead	1.38	0.363	0.4	1.3	9E-01	3E-01
	Mercury	0.07	0.0184	6.60	19.80	3E-03	9E-04
	Selenium	0.74	0.195	0.13	0.22	1E+00	9E-01
	Zinc	37.66	9.911	40	80	2E-01	1E-01
	TOTAL HI					**3E+00**	*1E+00*
Off-Site Soils	Arsenic	0.60	0.158	2.5	7.6	6E-02	2E-02
	Cadmium	1.46	0.384	0.8	1.7	5E-01	2E-01
	Copper	4.81	1.265	168	362	8E-03	3E-03
	Lead	6.00	1.578	0.4	1.3	**4E+00**	1E+00
	Mercury	0.23	0.060	6.60	19.80	9E-03	3E-03
	Selenium	0.74	0.195	0.13	0.22	1E+00	9E-01
	Zinc	85.03	22.376	40	80	6E-01	3E-01
	TOTAL HI					**6E+00**	**3E+00**
On-Site Soils	Arsenic	0.43	0.114	2.5	7.6	5E-02	2E-02
	Cadmium	0.48	0.128	0.8	1.7	2E-01	8E-02
	Copper	4.51	1.187	168	362	7E-03	3E-03
	Lead	4.21	1.108	0.4	1.3	**3E+00**	9E-01
	Mercury	0.11	0.028	6.60	19.80	4E-03	1E-03
	Selenium	0.74	0.195	0.13	0.22	1E+00	9E-01
	Zinc	62.25	16.381	40	80	4E-01	2E-01
	TOTAL HI					**5E+00**	**2E+00**
Site Tailings	Arsenic	2.66	0.699	2.5	7.6	3E-01	9E-02
	Cadmium	6.14	1.616	0.8	1.7	**2E+00**	1E+00
	Copper	13.23	3.481	168	362	2E-02	1E-02
	Lead	46.97	12.362	0.4	1.3	**3E+01**	**1E+01**
	Mercury	0.92	0.241	6.60	19.80	4E-02	1E-02
	Selenium	4.21	1.108	0.13	0.22	**8E+00**	**5E+00**
	Zinc	659.05	173.433	40	80	**4E+00**	**2E+00**
	TOTAL HI					**4E+01**	**2E+01**

HQs greater than one are shown in **boldface** type.
EPC is equal to the estimated plant concentration based on the minimum of the 95UCL and the maximum in soil.

Plant tissue concentrations were estimated using the equation: ln(conc in plant dw)=B_0+B_1(ln[conc in soil dw])
Dry weight concentrations were converted to wet weight using a conversion factor (CF) of 0.53 [DOI, 1998].
Mercury TRV is based on inorganic mercury.

Wildlife Hazard Quotients (HQs) for Ingestion of Terrestrial Plants
Wildlife Receptor - Greater-Sage Grouse

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (mg/kg ww)	Calculated Dose (mg/kg BW/day)	NOAEL TRV (mg/kg BW/day)	LOAEL TRV (mg/kg BW/day)	Plant Ingestion HQ NOAEL	Plant Ingestion HQ LOAEL
Background Soils	Arsenic	0.27	0.012	0.8	7.1	1E-02	2E-03
	Cadmium	0.33	0.014	0.1	2.4	2E-01	6E-03
	Copper	3.90	0.170	4	6	4E-02	3E-02
	Lead	1.38	0.060	0.9	1.8	7E-02	3E-02
	Mercury	0.07	0.0030	0.09	0.18	3E-02	2E-02
	Selenium	0.74	0.032	0.10	0.20	3E-01	2E-01
	Zinc	37.66	1.643	26	79	6E-02	2E-02
	TOTAL HI					*7E-01*	*3E-01*
Off-Site Soils	Arsenic	0.60	0.026	0.8	7.1	3E-02	4E-03
	Cadmium	1.46	0.064	0.1	2.4	7E-01	3E-02
	Copper	4.81	0.210	4	6	5E-02	3E-02
	Lead	6.00	0.262	0.9	1.8	3E-01	1E-01
	Mercury	0.23	0.010	0.09	0.18	1E-01	5E-02
	Selenium	0.74	0.032	0.10	0.20	3E-01	2E-01
	Zinc	85.03	3.710	26	79	1E-01	5E-02
	TOTAL HI					**2E+00**	*5E-01*
On-Site Soils	Arsenic	0.43	0.019	0.8	7.1	2E-02	3E-03
	Cadmium	0.48	0.021	0.1	2.4	2E-01	9E-03
	Copper	4.51	0.197	4	6	5E-02	3E-02
	Lead	4.21	0.184	0.9	1.8	2E-01	1E-01
	Mercury	0.11	0.005	0.09	0.18	5E-02	3E-02
	Selenium	0.74	0.032	0.10	0.20	3E-01	2E-01
	Zinc	62.25	2.716	26	79	1E-01	3E-02
	TOTAL HI					*1E+00*	*4E-01*
Site Tailings	Arsenic	2.66	0.116	0.8	7.1	1E-01	2E-02
	Cadmium	6.14	0.268	0.1	2.4	**3E+00**	1E-01
	Copper	13.23	0.577	4	6	1E-01	1E-01
	Lead	46.97	2.049	0.9	1.8	**2E+00**	1E+00
	Mercury	0.92	0.040	0.09	0.18	4E-01	2E-01
	Selenium	4.21	0.184	0.10	0.20	**2E+00**	9E-01
	Zinc	659.05	28.753	26	79	1E+00	4E-01
	TOTAL HI					**9E+00**	**3E+00**

HQs greater than one are shown in **boldface** type.
EPC is equal to the estimated plant concentration based on the minimum of the 95UCL and the maximum in soil.

Plant tissue concentrations were estimated using the equation: ln(conc in plant dw)=B_0+B_1(ln[conc in soil dw])
Dry weight concentrations were converted to wet weight using a conversion factor (CF) of 0.53 [DOI, 1998].
Mercury TRV is based on inorganic mercury.

Wildlife Hazard Quotients (HQs) for Ingestion of Small Mammals
Wildlife Receptor - American Kestrel

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

Designated Reach	Parameter	Maximum Estimated Concentration (mg/kg ww)	Calculated Dose (mg/kg BW/day)	NOAEL TRV (mg/kg BW/day)	LOAEL TRV (mg/kg BW/day)	Small Mammal Ingestion HQ NOAEL	Small Mammal Ingestion HQ LOAEL
Background Soils	Arsenic	0.04	0.01099	0.81	7.05	1E-02	2E-03
	Barium	3.03	0.869	2.78	5.55	3E-01	2E-01
	Cadmium	1.54	0.441	0.09	2.39	**5E+00**	2E-01
	Chromium	1.58	0.452	0.20	1.0	**2E+00**	5E-01
	Copper	10.16	2.917	4.02	6.03	7E-01	5E-01
	Lead	8.00	2.294	0.88	1.75	**3E+00**	1E+00
	Mercury	0.01	0.001589	0.05	0.18	4E-02	9E-03
	Selenium	0.63	0.1818	0.10	0.20	**2E+00**	9E-01
	Zinc	85.04	24.403	26	79	9E-01	3E-01
	TOTAL HI					**1E+01**	**4E+00**
Off-Site Soils	Arsenic	0.18	0.053	0.81	7.05	6E-02	7E-03
	Barium	3.79	1.086	2.78	5.55	4E-01	2E-01
	Cadmium	21.29	6.111	0.09	2.39	**7E+01**	**3E+00**
	Chromium	1.64	0.470	0.20	1.0	**2E+00**	5E-01
	Copper	11.18	3.207	4.02	6.03	8E-01	5E-01
	Lead	29.95	8.594	0.88	1.75	**1E+01**	**5E+00**
	Mercury	0.05	0.0140	0.05	0.18	3E-01	8E-02
	Selenium	0.63	0.1818	0.10	0.20	**2E+00**	9E-01
	Zinc	94.77	27.194	26	79	1E+00	3E-01
	TOTAL HI					**9E+01**	**1E+01**
On-Site Soils	Arsenic	0.09	0.0255	0.81	7.05	3E-02	4E-03
	Barium	3.16	0.908	2.78	5.55	3E-01	2E-01
	Cadmium	3.04	0.873	0.09	2.39	**1E+01**	4E-01
	Chromium	1.64	0.471	0.20	1.0	**2E+00**	5E-01
	Copper	10.86	3.116	4.02	6.03	8E-01	5E-01
	Lead	21.06	6.044	0.88	1.75	**7E+00**	**3E+00**
	Mercury	0.01	0.00342	0.05	0.18	8E-02	2E-02
	Selenium	0.63	0.18177	0.10	0.20	**2E+00**	9E-01
	Zinc	90.92	26.089	26	79	1E+00	3E-01
	TOTAL HI					**2E+01**	**6E+00**
Site Tailings	Arsenic	1.57	0.4492	0.81	7.05	6E-01	6E-02
	Barium	NA	NA	2.78	5.55	NC	NC
	Cadmium	58.40	16.757	0.09	2.39	**2E+02**	**7E+00**
	Chromium	1.94	0.557	0.20	1.0	**3E+00**	6E-01
	Copper	19.26	5.526	4.02	6.03	1E+00	9E-01
	Lead	75.34	21.619	0.88	1.75	**2E+01**	**1E+01**
	Mercury	0.44	0.1275	0.05	0.18	**3E+00**	7E-01
	Selenium	1.22	0.3502	0.10	0.20	**4E+00**	**2E+00**
	Zinc	114.96	32.988	26	79	1E+00	4E-01
	TOTAL HI					**2E+02**	**2E+01**

HQs greater than one are shown in boldface type.
EPC is equal to the estimated small mammal concentration based on the minimum of the 95UCL and the maximum in soil.

Small mammal tissue concentrations were estimated using the equation: ln(conc in small mammals dw)=B_0+B_1(ln[conc in soil dw])
Dry weight concentrations were converted to wet weight using a conversion factor (CF) of 0.68 [EPA, 1993]. dw = ww * CF
Mercury TRV is based on organic mercury.

Wildlife Hazard Quotients (HQs) for Ingestion of Small Mammals
Wildlife Receptor - Red Fox

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

Designated Reach	Parameter	Maximum Estimated Concentration (mg/kg ww)	Calculated Dose (mg/kg BW/day)	NOAEL TRV (mg/kg BW/day)	LOAEL TRV (mg/kg BW/day)	Small Mammal Ingestion HQ NOAEL	Small Mammal Ingestion HQ LOAEL
Background Soils	Arsenic	0.04	0.00262	0.20	0.60	1E-02	4E-03
	Barium	3.03	0.207	2.02	6.07	1E-01	3E-02
	Cadmium	1.54	0.105	0.50	0.99	2E-01	1E-01
	Chromium	1.58	0.108	800.00	2400.0	1E-04	4E-05
	Copper	10.16	0.694	2.21	3.21	3E-01	2E-01
	Lead	8.00	0.546	0.42	0.82	1E+00	7E-01
	Mercury	0.01	0.000378	0.06	0.10	6E-03	4E-03
	Selenium	0.63	0.0433	0.08	0.13	5E-01	3E-01
	Zinc	85.04	5.807	78	233	7E-02	2E-02
	TOTAL HI					**3E+00**	*1E+00*
Off-Site Soils	Arsenic	0.18	0.013	0.20	0.60	6E-02	2E-02
	Barium	3.79	0.258	2.02	6.07	1E-01	4E-02
	Cadmium	21.29	1.454	0.50	0.99	**3E+00**	1E+00
	Chromium	1.64	0.112	800.00	2400.0	1E-04	5E-05
	Copper	11.18	0.763	2.21	3.21	3E-01	2E-01
	Lead	29.95	2.045	0.42	0.82	**5E+00**	**3E+00**
	Mercury	0.05	0.0033	0.06	0.10	6E-02	3E-02
	Selenium	0.63	0.0433	0.08	0.13	5E-01	3E-01
	Zinc	94.77	6.471	78	233	8E-02	3E-02
	TOTAL HI					**9E+00**	**5E+00**
On-Site Soils	Arsenic	0.09	0.0061	0.20	0.60	3E-02	1E-02
	Barium	3.16	0.216	2.02	6.07	1E-01	4E-02
	Cadmium	3.04	0.208	0.50	0.99	4E-01	2E-01
	Chromium	1.64	0.112	800.00	2400.0	1E-04	5E-05
	Copper	10.86	0.741	2.21	3.21	3E-01	2E-01
	Lead	21.06	1.438	0.42	0.82	**3E+00**	**2E+00**
	Mercury	0.01	0.00081	0.06	0.10	1E-02	8E-03
	Selenium	0.63	0.04325	0.08	0.13	5E-01	3E-01
	Zinc	90.92	6.208	78	233	8E-02	3E-02
	TOTAL HI					**5E+00**	**3E+00**
Site Tailings	Arsenic	1.57	0.1069	0.20	0.60	5E-01	2E-01
	Barium	NA	NA	2.02	6.07	NC	NC
	Cadmium	58.40	3.987	0.50	0.99	**8E+00**	**4E+00**
	Chromium	1.94	0.133	800.00	2400.0	2E-04	6E-05
	Copper	19.26	1.315	2.21	3.21	6E-01	4E-01
	Lead	75.34	5.144	0.42	0.82	**1E+01**	**6E+00**
	Mercury	0.44	0.0303	0.06	0.10	5E-01	3E-01
	Selenium	1.22	0.0833	0.08	0.13	1E+00	6E-01
	Zinc	114.96	7.850	78	233	1E-01	3E-02
	TOTAL HI					**2E+01**	**1E+01**

HQs greater than one are shown in boldface type.
EPC is equal to the estimated small mammal concentration based on the minimum of the 95UCL and the maximum in soil.

Small mammal tissue concentrations were estimated using the equation: ln(conc in small mammals dw)=B_0+B_1(ln[conc in soil dw])
Dry weight concentrations were converted to wet weight using a conversion factor (CF) of 0.68 [EPA, 1993]. dw = ww * CF
Mercury TRV is based on organic mercury.

Wildlife Hazard Quotients (HQs) for Ingestion of Earthworms
Wildlife Receptor - American Robin

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (mg/kg ww)	Calculated Dose (mg/kg BW/day)	NOAEL TRV (mg/kg BW/day)	LOAEL TRV (mg/kg BW/day)	Earthworm Ingestion HQ NOAEL	Earthworm Ingestion HQ LOAEL
Background Soils	Arsenic	1.04	1.002	0.81	7.05	1E+00	1E-01
	Cadmium	6.96	6.701	0.09	2.39	**8E+01**	**3E+00**
	Copper	10.91	10.508	4.02	6.03	**3E+00**	**2E+00**
	Lead	18.06	17.396	0.88	1.75	**2E+01**	**1E+01**
	Mercury	0.48	0.462	0.045	0.181	**1E+01**	**3E+00**
	Selenium	1.53	1.469	0.10	0.20	**1E+01**	**7E+00**
	Zinc	351.97	339.038	26	79	**1E+01**	**4E+00**
	TOTAL HI					**1E+02**	**3E+01**
Off-Site Soils	Arsenic	3.00	2.891	0.81	7.05	**4E+00**	4E-01
	Cadmium	60.84	58.608	0.09	2.39	**7E+02**	**2E+01**
	Copper	12.55	12.092	4.02	6.03	**3E+00**	**2E+00**
	Lead	161.19	155.264	0.88	1.75	**2E+02**	**9E+01**
	Mercury	1.00	0.961	0.045	0.181	**2E+01**	**5E+00**
	Selenium	1.53	1.469	0.10	0.20	**1E+01**	**7E+00**
	Zinc	569.53	548.603	26	79	**2E+01**	**7E+00**
	TOTAL HI					**9E+02**	**1E+02**
On-Site Soils	Arsenic	1.92	1.845	0.81	7.05	**2E+00**	3E-01
	Cadmium	12.23	11.776	0.09	2.39	**1E+02**	**5E+00**
	Copper	12.03	11.586	4.02	6.03	**3E+00**	**2E+00**
	Lead	89.94	86.640	0.88	1.75	**1E+02**	**5E+01**
	Mercury	0.62	0.598	0.045	0.181	**1E+01**	**3E+00**
	Selenium	1.53	1.469	0.10	0.20	**1E+01**	**7E+00**
	Zinc	473.67	456.265	26	79	**2E+01**	**6E+00**
	TOTAL HI					**3E+02**	**7E+01**
Site Tailings	Arsenic	11.34	10.923	0.81	7.05	**1E+01**	**2E+00**
	Cadmium	139.83	134.690	0.09	2.39	**2E+03**	**6E+01**
	Copper	23.60	22.736	4.02	6.03	**6E+00**	**4E+00**
	Lead	743.63	716.308	0.88	1.75	**8E+02**	**4E+02**
	Mercury	2.10	2.023	0.045	0.181	**4E+01**	**1E+01**
	Selenium	5.47	5.269	0.10	0.20	**5E+01**	**3E+01**
	Zinc	1343.72	1294.358	26	79	**5E+01**	**2E+01**
	TOTAL HI					**3E+03**	**5E+02**

HQs greater than one are shown in boldface type.
EPC is equal to the estimated earthworm concentration based on the minimum of the 95UCL and the maximum in soil.

Earthworm tissue concentrations were estimated using the equation: ln(conc in earthworm dw)=B_0+B_1(ln[conc in soil dw])
Dry weight concentrations were converted to wet weight using a conversion factor (CF) of 0.84 [EPA, 1993]. dw = ww * CF
Mercury TRV is based on organic mercury.

Wildlife Hazard Quotients (HQs) for Ingestion of Earthworms
Wildlife Receptor - Masked Shrew

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (mg/kg ww)	Calculated Dose (mg/kg BW/day)	NOAEL TRV (mg/kg BW/day)	LOAEL TRV (mg/kg BW/day)	Earthworm Ingestion HQ NOAEL	Earthworm Ingestion HQ LOAEL
Background Soils	Arsenic	1.04	1.767	0.12	0.36	**1E+01**	**5E+00**
	Cadmium	6.96	11.813	0.50	0.99	**2E+01**	**1E+01**
	Copper	10.91	18.525	33.60	72.40	6E-01	3E-01
	Lead	18.06	30.667	0.08	0.25	**4E+02**	**1E+02**
	Mercury	0.48	0.814	0.005	0.023	**2E+02**	**4E+01**
	Selenium	1.53	2.590	0.08	0.13	**3E+01**	**2E+01**
	Zinc	351.97	597.681	24	48	**2E+01**	**1E+01**
	TOTAL HI					**6E+02**	**2E+02**
Off-Site Soils	Arsenic	3.00	5.096	0.12	0.36	**4E+01**	**1E+01**
	Cadmium	60.84	103.318	0.50	0.99	**2E+02**	**1E+02**
	Copper	12.55	21.316	33.60	72.40	6E-01	3E-01
	Lead	161.19	273.710	0.08	0.25	**3E+03**	**1E+03**
	Mercury	1.00	1.695	0.005	0.023	**4E+02**	**8E+01**
	Selenium	1.53	2.590	0.08	0.13	**3E+01**	**2E+01**
	Zinc	569.53	967.119	24	48	**4E+01**	**2E+01**
	TOTAL HI					**4E+03**	**1E+03**
On-Site Soils	Arsenic	1.92	3.252	0.12	0.36	**3E+01**	**9E+00**
	Cadmium	12.23	20.760	0.50	0.99	**4E+01**	**2E+01**
	Copper	12.03	20.425	33.60	72.40	6E-01	3E-01
	Lead	89.94	152.736	0.08	0.25	**2E+03**	**6E+02**
	Mercury	0.62	1.054	0.005	0.023	**2E+02**	**5E+01**
	Selenium	1.53	2.590	0.08	0.13	**3E+01**	**2E+01**
	Zinc	473.67	804.338	24	48	**3E+01**	**2E+01**
	TOTAL HI					**2E+03**	**7E+02**
Site Tailings	Arsenic	11.34	19.257	0.12	0.36	**2E+02**	**5E+01**
	Cadmium	139.83	237.442	0.50	0.99	**5E+02**	**2E+02**
	Copper	23.60	40.080	33.60	72.40	1E+00	6E-01
	Lead	743.63	1262.761	0.08	0.25	**2E+04**	**5E+03**
	Mercury	2.10	3.566	0.005	0.023	**8E+02**	**2E+02**
	Selenium	5.47	9.288	0.08	0.13	**1E+02**	**7E+01**
	Zinc	1343.72	2281.793	24	48	**1E+02**	**5E+01**
	TOTAL HI					**2E+04**	**6E+03**

HQs greater than one are shown in boldface type.
EPC is equal to the estimated earthworm concentration based on the minimum of the 95UCL and the maximum in soil.

Earthworm tissue concentrations were estimated using the equation: ln(conc in earthworm dw)=B_0+B_1(ln[conc in soil dw])
Dry weight concentrations were converted to wet weight using a conversion factor (CF) of 0.84 [EPA, 1993]. dw = ww * CF
Mercury TRV is based on organic mercury.

Hazard Quotients (HQs) for the Ingestion of Fish
Wildlife Receptor - Belted Kingfisher

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (mg/kg ww)*	Calculated Dose (mg/kg BW/day)	NOAEL TRV (mg/kg BW/day)	LOAEL TRV (mg/kg BW/day)	Fish Ingestion HQ	
						NOAEL	LOAEL
Upstream Silver Creek	Aluminum	15,220	7558.2313	7.0	35	**1E+03**	**2E+02**
	Antimony	889	441.4762	NA	NA	NC	NC
	Arsenic	1,735	861.5986	0.8	7.1	**1E+03**	**1E+02**
	Barium	NA	NA	2.8	5.6	NC	NC
	Cadmium	179	88.8912	0.09	2.4	**1E+03**	**4E+01**
	Chromium	42	20.8571	0.2	1.0	**1E+02**	**2E+01**
	Cobalt	NA	NA	0.3	0.5	NC	NC
	Copper	2,559	1270.7959	4.0	6.0	**3E+02**	**2E+02**
	Lead	42,990	21348.7755	0.9	1.8	**2E+04**	**1E+04**
	Manganese	NA	NA	65	195	NC	NC
	Mercury	1.6	0.7946	0.09	0.18	**9E+00**	**4E+00**
	Nickel	NA	NA	5.2	15	NC	NC
	Selenium	33.5	16.6361	0.100	0.20	**2E+02**	**8E+01**
	Thallium	NA	NA	NA	NA	NC	NC
	Vanadium	NA	NA	2.3	6.8	NC	NC
	Zinc	**44,560**	**22128.4354**	**26**	**79**	**8E+02**	**3E+02**
	TOTAL HI					**3E+04**	**1E+04**
Downstream Silver Creek	Aluminum	11,590	5755.5782	7.0	35	**8E+02**	**2E+02**
	Antimony	140	69.5238	NA	NA	NC	NC
	Arsenic	341	169.3401	0.8	7.1	**2E+02**	**2E+01**
	Barium	NA	NA	2.8	5.6	NC	NC
	Cadmium	58	28.8027	0.09	2.4	**3E+02**	**1E+01**
	Chromium	32	15.8912	0.2	1.0	**8E+01**	**2E+01**
	Cobalt	NA	NA	0.3	0.5	NC	NC
	Copper	766	380.3946	4.0	6.0	**9E+01**	**6E+01**
	Lead	11,130	5527.1429	0.9	1.8	**6E+03**	**3E+03**
	Manganese	NA	NA	65	195	NC	NC
	Mercury	0.44	0.2185	0.09	0.18	**2E+00**	1E+00
	Nickel	NA	NA	5.2	15	NC	NC
	Selenium	11	5.4626	0.100	0.20	**5E+01**	**3E+01**
	Thallium	NA	NA	NA	NA	NC	NC
	Vanadium	NA	NA	2.3	6.8	NC	NC
	Zinc	**11,950**	**5934.3537**	**26**	**79**	**2E+02**	**8E+01**
	TOTAL HI					**8E+03**	**4E+03**
South Diversion Ditch	Aluminum	15,125	7511.2714	7.0	35	**1E+03**	**2E+02**
	Antimony	93	46.1194	NA	NA	NC	NC
	Arsenic	163	80.8826	0.8	7.1	**1E+02**	**1E+01**
	Barium	NA	NA	2.8	5.6	NC	NC
	Cadmium	66.2	32.8656	0.09	2.4	**4E+02**	**1E+01**
	Chromium	23.5	11.6791	0.2	1.0	**6E+01**	**1E+01**
	Cobalt	NA	NA	0.3	0.5	NC	NC
	Copper	270	133.8966	4.0	6.0	**3E+01**	**2E+01**
	Lead	3,042	1510.5955	0.9	1.8	**2E+03**	**9E+02**
	Manganese	NA	NA	65	195	NC	NC
	Mercury	1.6	0.7946	0.09	0.18	**9E+00**	**4E+00**
	Nickel	NA	NA	5.2	15	NC	NC
	Selenium	7.0	3.4666	0.100	0.20	**3E+01**	**2E+01**
	Thallium	NA	NA	NA	NA	NC	NC
	Vanadium	NA	NA	2.3	6.8	NC	NC
	Zinc	**12,000**	**5959.1837**	**26**	**79**	**2E+02**	**8E+01**
	TOTAL HI					**4E+03**	**1E+03**
Wetlands Area	Aluminum	28,800	14302.0408	7.0	35	**2E+03**	**4E+02**
	Antimony	99	49.1633	NA	NA	NC	NC
	Arsenic	299.8	148.8654	0.8	7.1	**2E+02**	**2E+01**
	Barium	562	279.0884	2.8	5.6	**1E+02**	**5E+01**
	Cadmium	93.1	46.2333	0.09	2.4	**5E+02**	**2E+01**
	Chromium	62.4	30.9878	0.2	1.0	**2E+02**	**3E+01**
	Cobalt	20	9.9320	0.3	0.5	**4E+01**	**2E+01**
	Copper	725	360.0340	4.0	6.0	**9E+01**	**6E+01**
	Lead	6,520	3237.8231	0.9	1.8	**4E+03**	**2E+03**
	Manganese	42,000	20857.1429	65	195	**3E+02**	**1E+02**
	Mercury	8.2	4.0721	0.09	0.18	**5E+01**	**2E+01**
	Nickel	97.2	48.2694	5.2	15	**9E+00**	**3E+00**
	Selenium	43.1	21.4034	0.100	0.20	**2E+02**	**1E+02**
	Thallium	12.16	6.0395	NA	NA	NC	NC
	Vanadium	70.6	35.0599	2.3	6.8	**2E+01**	**5E+00**
	Zinc	**15,200**	**7548.2993**	**26**	**79**	**3E+02**	**1E+02**
	TOTAL HI					**8E+03**	**3E+03**

NA = Not Available
NC = Not Calculated

*Assumes a sediment to fish tissue bioaccumulation factor (BAF) of 1.
HQs greater than one are shown in boldface type.
EPC is equal to the minimum of the 95UCL and the maximum.
Mercury TRV is based on organic mercury.

Hazard Quotients (HQs) for the Ingestion of Fish
Wildlife Receptor - Mink

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (mg/kg ww)*	Calculated Dose (mg/kg BW/day)	NOAEL TRV (mg/kg BW/day)	LOAEL TRV (mg/kg BW/day)	Fish Ingestion HQ	
						NOAEL	LOAEL
Upstream Silver Creek	Aluminum	15,220	2436.2950	1.4	7	**2E+03**	**4E+02**
	Antimony	889	142.3040	0.01	0.02	**2E+04**	**8E+03**
	Arsenic	1,735	277.7248	0.2	0.5	**2E+03**	**6E+02**
	Barium	NA	NA	2.0	6.1	NC	NC
	Cadmium	179	28.6529	0.50	1.0	**6E+01**	**3E+01**
	Chromium	42	6.7230	800	2400.0	8E-03	3E-03
	Cobalt	NA	NA	1.3	4.0	NC	NC
	Copper	2,559	409.6241	8.8	12.8	**5E+01**	**3E+01**
	Lead	42,990	6881.4928	0.3	0.6	**2E+04**	**1E+04**
	Manganese	NA	NA	18	57	NC	NC
	Mercury	1.6	0.2561	1.37	4.11	2E-01	6E-02
	Nickel	NA	NA	8.0	24	NC	NC
	Selenium	33.5	5.3624	0.079	0.13	**7E+01**	**4E+01**
	Thallium	NA	NA	0.002	0.01	NC	NC
	Vanadium	NA	NA	0.7	2.0	NC	NC
	Zinc	**44,560**	7132.8058	311	933	**2E+01**	**8E+00**
	TOTAL HI					**5E+04**	**2E+04**
Downstream Silver Creek	Aluminum	11,590	1855.2338	1.4	7	**1E+03**	**3E+02**
	Antimony	140	22.4101	0.01	0.02	**4E+03**	**1E+03**
	Arsenic	341	54.5845	0.2	0.5	**4E+02**	**1E+02**
	Barium	NA	NA	2.0	6.1	NC	NC
	Cadmium	58	9.2842	0.50	1.0	**2E+01**	**9E+00**
	Chromium	32	5.1223	800	2400.0	6E-03	2E-03
	Cobalt	NA	NA	1.3	4.0	NC	NC
	Copper	766	122.6151	8.8	12.8	**1E+01**	**1E+01**
	Lead	11,130	1781.6007	0.3	0.6	**6E+03**	**3E+03**
	Manganese	NA	NA	18	57	NC	NC
	Mercury	0.44	0.0704	1.37	4.11	5E-02	2E-02
	Nickel	NA	NA	8.0	24	NC	NC
	Selenium	11	1.7608	0.079	0.13	**2E+01**	**1E+01**
	Thallium	NA	NA	0.002	0.01	NC	NC
	Vanadium	NA	NA	0.7	2.0	NC	NC
	Zinc	**11,950**	1912.8597	311	933	**6E+00**	**2E+00**
	TOTAL HI					**1E+04**	**5E+03**
South Diversion Ditch	Aluminum	15,125	2421.1581	1.4	7	**2E+03**	**4E+02**
	Antimony	93	14.8660	0.01	0.02	**2E+03**	**8E+02**
	Arsenic	163	26.0714	0.2	0.5	**2E+02**	**6E+01**
	Barium	NA	NA	2.0	6.1	NC	NC
	Cadmium	66.2	10.5938	0.50	1.0	**2E+01**	**1E+01**
	Chromium	23.5	3.7646	800	2400.0	5E-03	2E-03
	Cobalt	NA	NA	1.3	4.0	NC	NC
	Copper	270	43.1598	8.8	12.8	**5E+00**	**3E+00**
	Lead	3,042	486.9203	0.3	0.6	**2E+03**	**8E+02**
	Manganese	NA	NA	18	57	NC	NC
	Mercury	1.6	0.2561	1.37	4.11	2E-01	6E-02
	Nickel	NA	NA	8.0	24	NC	NC
	Selenium	7.0	1.1174	0.079	0.13	**1E+01**	**9E+00**
	Thallium	NA	NA	0.002	0.01	NC	NC
	Vanadium	NA	NA	0.7	2.0	NC	NC
	Zinc	**12,000**	1920.8633	311	933	**6E+00**	**2E+00**
	TOTAL HI					**6E+03**	**2E+03**
Wetlands Area	Aluminum	28,800	4610.0719	1.4	7	**3E+03**	**7E+02**
	Antimony	99	15.8471	0.01	0.02	**3E+03**	**8E+02**
	Arsenic	299.8	47.9848	0.2	0.5	**3E+02**	**1E+02**
	Barium	562	89.9604	2.0	6.1	**4E+01**	**1E+01**
	Cadmium	93.1	14.9027	0.50	1.0	**3E+01**	**2E+01**
	Chromium	62.4	9.9885	800	2400.0	1E-02	4E-03
	Cobalt	20	3.2014	1.3	4.0	**2E+00**	8E-01
	Copper	725	116.0522	8.8	12.8	**1E+01**	**9E+00**
	Lead	6,520	1043.6691	0.3	0.6	**3E+03**	**2E+03**
	Manganese	42,000	6723.0216	18	57	**4E+02**	**1E+02**
	Mercury	8.2	1.3126	1.37	4.11	1E+00	3E-01
	Nickel	97.2	15.5590	8.0	24	**2E+00**	6E-01
	Selenium	43.1	6.8991	0.079	0.13	**9E+01**	**5E+01**
	Thallium	12.16	1.9467	0.002	0.01	**1E+03**	**3E+02**
	Vanadium	70.6	11.3011	0.7	2.0	**2E+01**	**6E+00**
	Zinc	15,200	2433.0935	311	933	**8E+00**	**3E+00**
	TOTAL HI					**1E+04**	**4E+03**

NA = Not Available
NC = Not Calculated

*Assumes a sediment to fish tissue bioaccumulation factor (BAF) of 1.
HQs greater than one are shown in boldface type.
EPC is equal to the minimum of the 95UCL and the maximum.
Mercury TRV is based on organic mercury.

Hazard Quotients (HQs) for the Ingestion of Benthics
Wildlife Receptor - Mallard Duck

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

Designated Reach	Parameter	EPC (mg/kg ww)*	Calculated Dose (mg/kg BW/day)	NOAEL TRV (mg/kg BW/day)	LOAEL TRV (mg/kg BW/day)	Benthic Ingestion HQ	
						NOAEL	LOAEL
Upstream Silver Creek	Aluminum	2,283	635.8270	7.0	35	**9E+01**	**2E+01**
	Antimony	133	37.1386	NA	NA	NC	NC
	Arsenic	180	50.0118	0.8	7.1	**6E+01**	**7E+00**
	Barium	NA	NA	2.8	5.6	NC	NC
	Cadmium	1115.6175	310.7051	0.09	2.4	**4E+03**	**1E+02**
	Chromium	2.9484	0.8211	0.2	1.0	**4E+00**	8E-01
	Cobalt	NA	NA	0.3	0.5	NC	NC
	Copper	9,162	2551.8021	4.0	6.0	**6E+02**	**4E+02**
	Lead	3,914	1090.1354	0.9	1.8	**1E+03**	**6E+02**
	Manganese	NA	NA	65	195	NC	NC
	Mercury	0.68832	0.1917	0.09	0.18	**2E+00**	1E+00
	Nickel	NA	NA	5.2	15	NC	NC
	Selenium	4.8	1.3368	0.100	0.20	**1E+01**	**7E+00**
	Thallium	NA	NA	NA	NA	NC	NC
	Vanadium	NA	NA	2.3	6.8	NC	NC
	Zinc	**50,310**	**14011.7181**	**26**	**79**	**5E+02**	**2E+02**
	TOTAL HI					**6E+03**	**1E+03**
Downstream Silver Creek	Aluminum	1,739	484.1810	7.0	35	**7E+01**	**1E+01**
	Antimony	21	5.8486	NA	NA	NC	NC
	Arsenic	35.2935	9.8294	0.8	7.1	**1E+01**	1E+00
	Barium	NA	NA	2.8	5.6	NC	NC
	Cadmium	361.485	100.6754	0.09	2.4	**1E+03**	**4E+01**
	Chromium	2.2464	0.6256	0.2	1.0	**3E+00**	6E-01
	Cobalt	NA	NA	0.3	0.5	NC	NC
	Copper	2,743	763.8454	4.0	6.0	**2E+02**	**1E+02**
	Lead	1,013	282.2332	0.9	1.8	**3E+02**	**2E+02**
	Manganese	NA	NA	65	195	NC	NC
	Mercury	0.189288	0.0527	0.09	0.18	6E-01	3E-01
	Nickel	NA	NA	5.2	15	NC	NC
	Selenium	1.65	0.4595	0.100	0.20	**5E+00**	**2E+00**
	Thallium	NA	NA	NA	NA	NC	NC
	Vanadium	NA	NA	2.3	6.8	NC	NC
	Zinc	**13,492**	**3757.6309**	**26**	**79**	**1E+02**	**5E+01**
	TOTAL HI					**2E+03**	**4E+02**
South Diversion Ditch	Aluminum	2,269	631.8765	7.0	35	**9E+01**	**2E+01**
	Antimony	14	3.8797	NA	NA	NC	NC
	Arsenic	17	4.6949	0.8	7.1	**6E+00**	7E-01
	Barium	NA	NA	2.8	5.6	NC	NC
	Cadmium	412.5	114.8764	0.09	2.4	**1E+03**	**5E+01**
	Chromium	1.7	0.4598	0.2	1.0	**2E+00**	5E-01
	Cobalt	NA	NA	0.3	0.5	NC	NC
	Copper	965	268.8689	4.0	6.0	**7E+01**	**4E+01**
	Lead	277	77.1357	0.9	1.8	**9E+01**	**4E+01**
	Manganese	NA	NA	65	195	NC	NC
	Mercury	0.68832	0.1917	0.09	0.18	**2E+00**	1E+00
	Nickel	NA	NA	5.2	15	NC	NC
	Selenium	1.0	0.2916	0.100	0.20	**3E+00**	1E+00
	Thallium	NA	NA	NA	NA	NC	NC
	Vanadium	NA	NA	2.3	6.8	NC	NC
	Zinc	**13,549**	**3773.3532**	**26**	**79**	**1E+02**	**5E+01**
	TOTAL HI					**2E+03**	**2E+02**
Wetlands Area	Aluminum	4,320	1203.1417	7.0	35	**2E+02**	**3E+01**
	Antimony	15	4.1358	NA	NA	NC	NC
	Arsenic	31.0	8.6410	0.8	7.1	**1E+01**	1E+00
	Barium	84.3	23.4780	2.8	5.6	**8E+00**	**4E+00**
	Cadmium	580.24575	161.6014	0.09	2.4	**2E+03**	**7E+01**
	Chromium	4.38048	1.2200	0.2	1.0	**6E+00**	1E+00
	Cobalt	15.75	4.3865	0.3	0.5	**2E+01**	**8E+00**
	Copper	2,596	722.9607	4.0	6.0	**2E+02**	**1E+02**
	Lead	594	165.3334	0.9	1.8	**2E+02**	**9E+01**
	Manganese	6,300	1754.5816	65	195	**3E+01**	**9E+00**
	Mercury	3.52764	0.9825	0.09	0.18	**1E+01**	**5E+00**
	Nickel	33.8256	9.4206	5.2	15	**2E+00**	6E-01
	Selenium	6.465	1.8005	0.100	0.20	**2E+01**	**9E+00**
	Thallium	1.82	0.5081	NA	NA	NC	NC
	Vanadium	10.59	2.9494	2.3	6.8	1E+00	4E-01
	Zinc	**17,162**	**4779.5807**	**26**	**79**	**2E+02**	**6E+01**
	TOTAL HI					**3E+03**	**4E+02**

NA = Not Available
NC = Not Calculated

Benthic tissue concentrations were estimated using the equation: (conc in benthics dw) = BSAF * (conc in soil dw)
Dry weight concentrations were converted to wet weight using a conversion factor (CF) of 0.15 [USFWS, 1998].
HQs greater than one are shown in boldface type.
Mercury TRV is based on organic mercury.

APPENDIX F

CALCULATION OF HAZARDS FOR PLANTS FROM DIRECT CONTACT WITH SOILS/TAILINGS

APPENDIX F
Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

* Average concentration across all depths; duplicate/split samples averaged with field samples.

Reach	Parameter	Station ID	Conc (mg/kg)*	Plant Benchmark (mg/kg dw)		Soil HQ	
				Low	High	Low	High
Background Soils	Arsenic	RF-BG-BG1	11.0	10	100	1E+00	1E-01
Background Soils	Lead	RF-BG-BG1	47.0	50	1000	9E-01	5E-02
Background Soils	Arsenic	RF-BG-BG10	7.0	10	100	7E-01	7E-02
Background Soils	Barium	RF-BG-BG10	220.0	500	NA	4E-01	*NC*
Background Soils	Cadmium	RF-BG-BG10	0.3	4	100	6E-02	3E-03
Background Soils	Chromium	RF-BG-BG10	22.5	1	NA	***2E+01***	*NC*
Background Soils	Copper	RF-BG-BG10	15.5	100	NA	2E-01	*NC*
Background Soils	Lead	RF-BG-BG10	30.5	50	1000	6E-01	3E-02
Background Soils	Mercury	RF-BG-BG10	0.1	35	NA	1E-03	*NC*
Background Soils	Selenium	RF-BG-BG10	2.5	1	NA	***3E+00***	*NC*
Background Soils	Silver	RF-BG-BG10	2.5	2	NA	1E+00	*NC*
Background Soils	Zinc	RF-BG-BG10	93.0	50	500	***2E+00***	2E-01
Background Soils	Arsenic	RF-BG-BG2	8.1	10	100	8E-01	8E-02
Background Soils	Lead	RF-BG-BG2	26.0	50	1000	5E-01	3E-02
Background Soils	Arsenic	RF-BG-BG3	8.6	10	100	9E-01	9E-02
Background Soils	Lead	RF-BG-BG3	22.0	50	1000	4E-01	2E-02
Background Soils	Arsenic	RF-BG-BG4	9.2	10	100	9E-01	9E-02
Background Soils	Lead	RF-BG-BG4	25.0	50	1000	5E-01	3E-02
Background Soils	Arsenic	RF-BG-BG5	11.0	10	100	1E+00	1E-01
Background Soils	Lead	RF-BG-BG5	43.0	50	1000	9E-01	4E-02
Background Soils	Arsenic	RF-BG-BG6	7.0	10	100	7E-01	7E-02
Background Soils	Lead	RF-BG-BG6	30.0	50	1000	6E-01	3E-02
Background Soils	Arsenic	RF-BG-BG7	6.9	10	100	7E-01	7E-02
Background Soils	Lead	RF-BG-BG7	25.0	50	1000	5E-01	3E-02
Background Soils	Arsenic	RF-BG-BG8	14.0	10	100	1E+00	1E-01
Background Soils	Barium	RF-BG-BG8	265.0	500	NA	5E-01	*NC*
Background Soils	Cadmium	RF-BG-BG8	1.0	4	100	3E-01	1E-02
Background Soils	Chromium	RF-BG-BG8	20.0	1	NA	***2E+01***	*NC*
Background Soils	Copper	RF-BG-BG8	29.0	100	NA	3E-01	*NC*
Background Soils	Lead	RF-BG-BG8	84.0	50	1000	***2E+00***	8E-02
Background Soils	Mercury	RF-BG-BG8	0.2	35	NA	4E-03	*NC*
Background Soils	Selenium	RF-BG-BG8	2.5	1	NA	***3E+00***	*NC*
Background Soils	Silver	RF-BG-BG8	2.5	2	NA	1E+00	*NC*
Background Soils	Zinc	RF-BG-BG8	127.0	50	500	***3E+00***	3E-01
Background Soils	Arsenic	RF-BG-BG9	6.7	10	100	7E-01	7E-02
Background Soils	Lead	RF-BG-BG9	98.0	50	1000	***2E+00***	1E-01
Off-Impoundment Soils	Arsenic	RF-OF-T1A	26.0	10	100	***3E+00***	3E-01
Off-Impoundment Soils	Lead	RF-OF-T1A	470.5	50	1000	***9E+00***	5E-01
Off-Impoundment Soils	Arsenic	RF-OF-T1B	11.0	10	100	1E+00	1E-01
Off-Impoundment Soils	Lead	RF-OF-T1B	101.0	50	1000	***2E+00***	1E-01
Off-Impoundment Soils	Arsenic	RF-OF-T1C	8.5	10	100	9E-01	9E-02
Off-Impoundment Soils	Barium	RF-OF-T1C	193.5	500	NA	4E-01	*NC*
Off-Impoundment Soils	Cadmium	RF-OF-T1C	1.0	4	100	3E-01	1E-02
Off-Impoundment Soils	Chromium	RF-OF-T1C	21.5	1	NA	***2E+01***	*NC*
Off-Impoundment Soils	Copper	RF-OF-T1C	24.0	100	NA	2E-01	*NC*
Off-Impoundment Soils	Lead	RF-OF-T1C	77.0	50	1000	***2E+00***	8E-02
Off-Impoundment Soils	Mercury	RF-OF-T1C	0.1	35	NA	1E-03	*NC*
Off-Impoundment Soils	Selenium	RF-OF-T1C	2.5	1	NA	***3E+00***	*NC*
Off-Impoundment Soils	Silver	RF-OF-T1C	2.5	2	NA	1E+00	*NC*
Off-Impoundment Soils	Zinc	RF-OF-T1C	145.0	50	500	***3E+00***	3E-01
Off-Impoundment Soils	Arsenic	RF-OF-T1D	8.5	10	100	8E-01	8E-02
Off-Impoundment Soils	Lead	RF-OF-T1D	76.0	50	1000	***2E+00***	8E-02
Off-Impoundment Soils	Arsenic	RF-OF-T1E	9.1	10	100	9E-01	9E-02
Off-Impoundment Soils	Lead	RF-OF-T1E	53.3	50	1000	1E+00	5E-02
Off-Impoundment Soils	Arsenic	RF-OF-T1F	10.5	10	100	1E+00	1E-01
Off-Impoundment Soils	Lead	RF-OF-T1F	64.5	50	1000	1E+00	6E-02
Off-Impoundment Soils	Arsenic	RF-OF-T1G	9.2	10	100	9E-01	9E-02
Off-Impoundment Soils	Lead	RF-OF-T1G	46.5	50	1000	9E-01	5E-02
Off-Impoundment Soils	Arsenic	RF-OF-T1H	10.0	10	100	1E+00	1E-01
Off-Impoundment Soils	Lead	RF-OF-T1H	32.5	50	1000	7E-01	3E-02
Off-Impoundment Soils	Arsenic	RF-OF-T2A	37.0	10	100	***4E+00***	4E-01
Off-Impoundment Soils	Lead	RF-OF-T2A	471.0	50	1000	***9E+00***	5E-01
Off-Impoundment Soils	Arsenic	RF-OF-T2B	13.0	10	100	1E+00	1E-01
Off-Impoundment Soils	Lead	RF-OF-T2B	120.5	50	1000	***2E+00***	1E-01

APPENDIX F
Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

* Average concentration across all depths; duplicate/split samples averaged with field samples.

Reach	Parameter	Station ID	Conc (mg/kg)*	Plant Benchmark (mg/kg dw)		Soil HQ	
				Low	High	Low	High
Off-Impoundment Soils	Arsenic	RF-OF-T2C	129.0	10	100	***1E+01***	1E+00
Off-Impoundment Soils	Lead	RF-OF-T2C	3,308.0	50	1000	***7E+01***	***3E+00***
Off-Impoundment Soils	Arsenic	RF-OF-T2D	279.5	10	100	***3E+01***	***3E+00***
Off-Impoundment Soils	Lead	RF-OF-T2D	6,070.0	50	1000	***1E+02***	***6E+00***
Off-Impoundment Soils	Arsenic	RF-OF-T2E	245.5	10	100	***2E+01***	***2E+00***
Off-Impoundment Soils	Lead	RF-OF-T2E	5,179.5	50	1000	***1E+02***	***5E+00***
Off-Impoundment Soils	Arsenic	RF-OF-T2F	11.3	10	100	1E+00	1E-01
Off-Impoundment Soils	Barium	RF-OF-T2F	233.8	500	NA	5E-01	***NC***
Off-Impoundment Soils	Cadmium	RF-OF-T2F	0.9	4	100	2E-01	9E-03
Off-Impoundment Soils	Chromium	RF-OF-T2F	21.5	1	NA	***2E+01***	***NC***
Off-Impoundment Soils	Copper	RF-OF-T2F	30.3	100	NA	3E-01	***NC***
Off-Impoundment Soils	Lead	RF-OF-T2F	112.5	50	1000	***2E+00***	1E-01
Off-Impoundment Soils	Mercury	RF-OF-T2F	0.1	35	NA	1E-03	***NC***
Off-Impoundment Soils	Selenium	RF-OF-T2F	2.5	1	NA	***3E+00***	***NC***
Off-Impoundment Soils	Silver	RF-OF-T2F	2.5	2	NA	1E+00	***NC***
Off-Impoundment Soils	Zinc	RF-OF-T2F	178.3	50	500	***4E+00***	4E-01
Off-Impoundment Soils	Arsenic	RF-OF-T2G	7.6	10	100	8E-01	8E-02
Off-Impoundment Soils	Lead	RF-OF-T2G	19.5	50	1000	4E-01	2E-02
Off-Impoundment Soils	Arsenic	RF-OF-T2H	8.0	10	100	8E-01	8E-02
Off-Impoundment Soils	Barium	RF-OF-T2H	303.0	500	NA	6E-01	***NC***
Off-Impoundment Soils	Cadmium	RF-OF-T2H	0.6	4	100	2E-01	6E-03
Off-Impoundment Soils	Chromium	RF-OF-T2H	30.5	1	NA	***3E+01***	***NC***
Off-Impoundment Soils	Copper	RF-OF-T2H	24.0	100	NA	2E-01	***NC***
Off-Impoundment Soils	Lead	RF-OF-T2H	48.0	50	1000	1E+00	5E-02
Off-Impoundment Soils	Mercury	RF-OF-T2H	0.1	35	NA	1E-03	***NC***
Off-Impoundment Soils	Selenium	RF-OF-T2H	2.5	1	NA	***3E+00***	***NC***
Off-Impoundment Soils	Silver	RF-OF-T2H	2.5	2	NA	1E+00	***NC***
Off-Impoundment Soils	Zinc	RF-OF-T2H	93.0	50	500	***2E+00***	2E-01
Off-Impoundment Soils	Arsenic	RF-OF-T2I	7.4	10	100	7E-01	7E-02
Off-Impoundment Soils	Lead	RF-OF-T2I	46.5	50	1000	9E-01	5E-02
Off-Impoundment Soils	Arsenic	RF-OF-T2J	8.5	10	100	9E-01	9E-02
Off-Impoundment Soils	Lead	RF-OF-T2J	39.5	50	1000	8E-01	4E-02
Off-Impoundment Soils	Arsenic	RF-OF-T3A	9.3	10	100	9E-01	9E-02
Off-Impoundment Soils	Lead	RF-OF-T3A	55.0	50	1000	1E+00	6E-02
Off-Impoundment Soils	Arsenic	RF-OF-T3B	37.0	10	100	***4E+00***	4E-01
Off-Impoundment Soils	Barium	RF-OF-T3B	225.5	500	NA	5E-01	***NC***
Off-Impoundment Soils	Cadmium	RF-OF-T3B	29.5	4	100	***7E+00***	3E-01
Off-Impoundment Soils	Chromium	RF-OF-T3B	20.5	1	NA	***2E+01***	***NC***
Off-Impoundment Soils	Copper	RF-OF-T3B	89.5	100	NA	9E-01	***NC***
Off-Impoundment Soils	Lead	RF-OF-T3B	812.5	50	1000	***2E+01***	8E-01
Off-Impoundment Soils	Mercury	RF-OF-T3B	3.1	35	NA	9E-02	***NC***
Off-Impoundment Soils	Selenium	RF-OF-T3B	2.5	1	NA	***3E+00***	***NC***
Off-Impoundment Soils	Silver	RF-OF-T3B	2.5	2	NA	1E+00	***NC***
Off-Impoundment Soils	Zinc	RF-OF-T3B	1,366.5	50	500	***3E+01***	***3E+00***
Off-Impoundment Soils	Arsenic	RF-OF-T3C	8.6	10	100	9E-01	9E-02
Off-Impoundment Soils	Lead	RF-OF-T3C	53.5	50	1000	1E+00	5E-02
Off-Impoundment Soils	Arsenic	RF-OF-T3D	7.5	10	100	8E-01	8E-02
Off-Impoundment Soils	Barium	RF-OF-T3D	403.0	500	NA	8E-01	***NC***
Off-Impoundment Soils	Cadmium	RF-OF-T3D	1.0	4	100	3E-01	1E-02
Off-Impoundment Soils	Chromium	RF-OF-T3D	21.3	1	NA	***2E+01***	***NC***
Off-Impoundment Soils	Copper	RF-OF-T3D	33.3	100	NA	3E-01	***NC***
Off-Impoundment Soils	Lead	RF-OF-T3D	53.5	50	1000	1E+00	5E-02
Off-Impoundment Soils	Mercury	RF-OF-T3D	0.1	35	NA	2E-03	***NC***
Off-Impoundment Soils	Selenium	RF-OF-T3D	2.5	1	NA	***3E+00***	***NC***
Off-Impoundment Soils	Silver	RF-OF-T3D	2.5	2	NA	1E+00	***NC***
Off-Impoundment Soils	Zinc	RF-OF-T3D	138.3	50	500	***3E+00***	3E-01
Off-Impoundment Soils	Arsenic	RF-OF-T3E	6.7	10	100	7E-01	7E-02
Off-Impoundment Soils	Lead	RF-OF-T3E	17.5	50	1000	4E-01	2E-02
Off-Impoundment Soils	Arsenic	RF-OF-T3F	7.5	10	100	7E-01	7E-02
Off-Impoundment Soils	Lead	RF-OF-T3F	19.0	50	1000	4E-01	2E-02
Off-Impoundment Soils	Arsenic	RF-OF-T3G	6.5	10	100	7E-01	7E-02
Off-Impoundment Soils	Lead	RF-OF-T3G	27.5	50	1000	6E-01	3E-02
Off-Impoundment Soils	Arsenic	RF-OF-T3H	7.0	10	100	7E-01	7E-02
Off-Impoundment Soils	Lead	RF-OF-T3H	27.0	50	1000	5E-01	3E-02

APPENDIX F
Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

* Average concentration across all depths; duplicate/split samples averaged with field samples.

Reach	Parameter	Station ID	Conc (mg/kg)*	Plant Benchmark (mg/kg dw)		Soil HQ	
				Low	High	Low	High
Off-Impoundment Soils	Arsenic	RF-OF-T3I	9.2	10	100	9E-01	9E-02
Off-Impoundment Soils	Lead	RF-OF-T3I	25.0	50	1000	5E-01	3E-02
Off-Impoundment Soils	Arsenic	RF-OF-T3J	9.2	10	100	9E-01	9E-02
Off-Impoundment Soils	Lead	RF-OF-T3J	47.0	50	1000	9E-01	5E-02
Off-Impoundment Soils	Arsenic	SAB-1	12.0	10	100	1E+00	1E-01
Off-Impoundment Soils	Lead	SAB-1	98.0	50	1000	***2E+00***	1E-01
Off-Impoundment Soils	Arsenic	SAB-2	14.0	10	100	1E+00	1E-01
Off-Impoundment Soils	Lead	SAB-2	135.0	50	1000	***3E+00***	1E-01
Off-Impoundment Soils	Arsenic	SAB-3	11.0	10	100	1E+00	1E-01
Off-Impoundment Soils	Lead	SAB-3	75.0	50	1000	***2E+00***	8E-02
Off-Impoundment Soils	Arsenic	SAB-4	12.0	10	100	1E+00	1E-01
Off-Impoundment Soils	Lead	SAB-4	144.0	50	1000	***3E+00***	1E-01
Off-Impoundment Soils	Arsenic	SAB-5	12.0	10	100	1E+00	1E-01
Off-Impoundment Soils	Lead	SAB-5	53.0	50	1000	1E+00	5E-02
Off-Impoundment Soils	Arsenic	SAB-7	30.0	10	100	***3E+00***	3E-01
Off-Impoundment Soils	Lead	SAB-7	165.0	50	1000	***3E+00***	2E-01
Off-Impoundment Soils	Arsenic	SAB-8	23.0	10	100	***2E+00***	2E-01
Off-Impoundment Soils	Lead	SAB-8	63.0	50	1000	1E+00	6E-02
On-Impoundment Soils	Arsenic	RF-ON-1A	15.0	10	100	***2E+00***	2E-01
On-Impoundment Soils	Lead	RF-ON-1A	37.0	50	1000	7E-01	4E-02
On-Impoundment Soils	Arsenic	RF-ON-1B	9.1	10	100	9E-01	9E-02
On-Impoundment Soils	Lead	RF-ON-1B	44.0	50	1000	9E-01	4E-02
On-Impoundment Soils	Arsenic	RF-ON-1C	12.0	10	100	1E+00	1E-01
On-Impoundment Soils	Lead	RF-ON-1C	163.0	50	1000	***3E+00***	2E-01
On-Impoundment Soils	Arsenic	RF-ON-1D	10.0	10	100	1E+00	1E-01
On-Impoundment Soils	Lead	RF-ON-1D	96.0	50	1000	***2E+00***	1E-01
On-Impoundment Soils	Arsenic	RF-ON-1E	20.0	10	100	***2E+00***	2E-01
On-Impoundment Soils	Lead	RF-ON-1E	336.0	50	1000	***7E+00***	3E-01
On-Impoundment Soils	Arsenic	RF-ON-1G	121.0	10	100	***1E+01***	1E+00
On-Impoundment Soils	Lead	RF-ON-1G	3,239.0	50	1000	***6E+01***	***3E+00***
On-Impoundment Soils	Arsenic	RF-ON-2A	13.0	10	100	1E+00	1E-01
On-Impoundment Soils	Lead	RF-ON-2A	49.0	50	1000	1E+00	5E-02
On-Impoundment Soils	Arsenic	RF-ON-2B	78.0	10	100	***8E+00***	8E-01
On-Impoundment Soils	Lead	RF-ON-2B	1,155.0	50	1000	***2E+01***	1E+00
On-Impoundment Soils	Arsenic	RF-ON-2C	7.8	10	100	8E-01	8E-02
On-Impoundment Soils	Lead	RF-ON-2C	19.0	50	1000	4E-01	2E-02
On-Impoundment Soils	Arsenic	RF-ON-2D	6.8	10	100	7E-01	7E-02
On-Impoundment Soils	Lead	RF-ON-2D	19.5	50	1000	4E-01	2E-02
On-Impoundment Soils	Arsenic	RF-ON-2E	44.0	10	100	***4E+00***	4E-01
On-Impoundment Soils	Lead	RF-ON-2E	904.5	50	1000	***2E+01***	9E-01
On-Impoundment Soils	Arsenic	RF-ON-2F	82.0	10	100	***8E+00***	8E-01
On-Impoundment Soils	Lead	RF-ON-2F	2,646.0	50	1000	***5E+01***	***3E+00***
On-Impoundment Soils	Arsenic	RF-ON-2G	12.0	10	100	1E+00	1E-01
On-Impoundment Soils	Lead	RF-ON-2G	59.0	50	1000	1E+00	6E-02
On-Impoundment Soils	Aluminum	RF-ON-2H	22,600.0	50	NA	***5E+02***	***NC***
On-Impoundment Soils	Antimony	RF-ON-2H	2.5	5	NA	5E-01	***NC***
On-Impoundment Soils	Arsenic	RF-ON-2H	3.7	10	100	4E-01	4E-02
On-Impoundment Soils	Barium	RF-ON-2H	206.0	500	NA	4E-01	***NC***
On-Impoundment Soils	Cadmium	RF-ON-2H	0.5	4	100	1E-01	5E-03
On-Impoundment Soils	Chromium	RF-ON-2H	22.3	1	NA	***2E+01***	***NC***
On-Impoundment Soils	Copper	RF-ON-2H	15.0	100	NA	2E-01	***NC***
On-Impoundment Soils	Lead	RF-ON-2H	25.3	50	1000	5E-01	3E-02
On-Impoundment Soils	Mercury	RF-ON-2H	0.1	35	NA	1E-03	***NC***
On-Impoundment Soils	Selenium	RF-ON-2H	2.5	1	NA	***3E+00***	***NC***
On-Impoundment Soils	Silver	RF-ON-2H	2.5	2	NA	1E+00	***NC***
On-Impoundment Soils	Zinc	RF-ON-2H	91.3	50	500	***2E+00***	2E-01
On-Impoundment Soils	Arsenic	RF-ON-3A	49.0	10	100	***5E+00***	5E-01
On-Impoundment Soils	Barium	RF-ON-3A	210.0	500	NA	4E-01	***NC***
On-Impoundment Soils	Cadmium	RF-ON-3A	6.0	4	100	***2E+00***	6E-02
On-Impoundment Soils	Chromium	RF-ON-3A	24.0	1	NA	***2E+01***	***NC***
On-Impoundment Soils	Copper	RF-ON-3A	99.0	100	NA	1E+00	***NC***
On-Impoundment Soils	Lead	RF-ON-3A	875.0	50	1000	***2E+01***	9E-01
On-Impoundment Soils	Mercury	RF-ON-3A	0.7	35	NA	2E-02	***NC***
On-Impoundment Soils	Selenium	RF-ON-3A	2.5	1	NA	***3E+00***	***NC***

APPENDIX F
Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

* Average concentration across all depths; duplicate/split samples averaged with field samples.

Reach	Parameter	Station ID	Conc (mg/kg)*	Plant Benchmark (mg/kg dw)		Soil HQ	
				Low	High	Low	High
On-Impoundment Soils	Silver	RF-ON-3A	2.5	2	NA	1E+00	*NC*
On-Impoundment Soils	Zinc	RF-ON-3A	1,010.0	50	500	***2E+01***	***2E+00***
On-Impoundment Soils	Aluminum	RF-ON-3B	22,400.0	50	NA	***4E+02***	*NC*
On-Impoundment Soils	Antimony	RF-ON-3B	2.5	5	NA	5E-01	*NC*
On-Impoundment Soils	Arsenic	RF-ON-3B	36.0	10	100	***4E+00***	4E-01
On-Impoundment Soils	Cadmium	RF-ON-3B	1.0	4	100	3E-01	1E-02
On-Impoundment Soils	Chromium	RF-ON-3B	20.0	1	NA	***2E+01***	*NC*
On-Impoundment Soils	Copper	RF-ON-3B	53.0	100	NA	5E-01	*NC*
On-Impoundment Soils	Lead	RF-ON-3B	528.5	50	1000	***1E+01***	5E-01
On-Impoundment Soils	Mercury	RF-ON-3B	0.2	35	NA	5E-03	*NC*
On-Impoundment Soils	Selenium	RF-ON-3B	2.5	1	NA	***3E+00***	*NC*
On-Impoundment Soils	Silver	RF-ON-3B	2.5	2	NA	1E+00	*NC*
On-Impoundment Soils	Zinc	RF-ON-3B	242.0	50	500	***5E+00***	5E-01
On-Impoundment Soils	Arsenic	RF-ON-3C	6.2	10	100	6E-01	6E-02
On-Impoundment Soils	Lead	RF-ON-3C	15.0	50	1000	3E-01	2E-02
On-Impoundment Soils	Aluminum	RF-ON-3D	17,600.0	50	NA	***4E+02***	*NC*
On-Impoundment Soils	Antimony	RF-ON-3D	10.0	5	NA	***2E+00***	*NC*
On-Impoundment Soils	Arsenic	RF-ON-3D	46.0	10	100	***5E+00***	5E-01
On-Impoundment Soils	Barium	RF-ON-3D	255.0	500	NA	5E-01	*NC*
On-Impoundment Soils	Cadmium	RF-ON-3D	3.5	4	100	9E-01	4E-02
On-Impoundment Soils	Chromium	RF-ON-3D	24.5	1	NA	***2E+01***	*NC*
On-Impoundment Soils	Copper	RF-ON-3D	84.5	100	NA	8E-01	*NC*
On-Impoundment Soils	Lead	RF-ON-3D	574.5	50	1000	***1E+01***	6E-01
On-Impoundment Soils	Mercury	RF-ON-3D	1.0	35	NA	3E-02	*NC*
On-Impoundment Soils	Selenium	RF-ON-3D	2.5	1	NA	***3E+00***	*NC*
On-Impoundment Soils	Silver	RF-ON-3D	2.5	2	NA	1E+00	*NC*
On-Impoundment Soils	Zinc	RF-ON-3D	748.0	50	500	***1E+01***	1E+00
On-Impoundment Soils	Aluminum	RF-ON-3E	21,800.0	50	NA	***4E+02***	*NC*
On-Impoundment Soils	Antimony	RF-ON-3E	2.5	5	NA	5E-01	*NC*
On-Impoundment Soils	Arsenic	RF-ON-3E	4.0	10	100	4E-01	4E-02
On-Impoundment Soils	Barium	RF-ON-3E	360.5	500	NA	7E-01	*NC*
On-Impoundment Soils	Cadmium	RF-ON-3E	0.3	4	100	6E-02	3E-03
On-Impoundment Soils	Chromium	RF-ON-3E	21.7	1	NA	***2E+01***	*NC*
On-Impoundment Soils	Copper	RF-ON-3E	21.3	100	NA	2E-01	*NC*
On-Impoundment Soils	Lead	RF-ON-3E	21.0	50	1000	4E-01	2E-02
On-Impoundment Soils	Mercury	RF-ON-3E	0.1	35	NA	1E-03	*NC*
On-Impoundment Soils	Selenium	RF-ON-3E	2.5	1	NA	***3E+00***	*NC*
On-Impoundment Soils	Silver	RF-ON-3E	2.5	2	NA	1E+00	*NC*
On-Impoundment Soils	Zinc	RF-ON-3E	62.0	50	500	1E+00	1E-01
On-Impoundment Soils	Arsenic	RF-ON-3F	23.0	10	100	***2E+00***	2E-01
On-Impoundment Soils	Lead	RF-ON-3F	231.0	50	1000	***5E+00***	2E-01
On-Impoundment Soils	Arsenic	RF-ON-3G	12.0	10	100	1E+00	1E-01
On-Impoundment Soils	Lead	RF-ON-3G	23.0	50	1000	5E-01	2E-02
On-Impoundment Soils	Arsenic	RF-ON-3H	7.5	10	100	8E-01	8E-02
On-Impoundment Soils	Lead	RF-ON-3H	25.0	50	1000	5E-01	3E-02
On-Impoundment Soils	Arsenic	RF-ON-3I	9.0	10	100	9E-01	9E-02
On-Impoundment Soils	Barium	RF-ON-3I	187.0	500	NA	4E-01	*NC*
On-Impoundment Soils	Cadmium	RF-ON-3I	1.0	4	100	3E-01	1E-02
On-Impoundment Soils	Chromium	RF-ON-3I	20.0	1	NA	***2E+01***	*NC*
On-Impoundment Soils	Copper	RF-ON-3I	25.0	100	NA	3E-01	*NC*
On-Impoundment Soils	Lead	RF-ON-3I	127.0	50	1000	***3E+00***	1E-01
On-Impoundment Soils	Mercury	RF-ON-3I	0.1	35	NA	1E-03	*NC*
On-Impoundment Soils	Selenium	RF-ON-3I	2.5	1	NA	***3E+00***	*NC*
On-Impoundment Soils	Silver	RF-ON-3I	2.5	2	NA	1E+00	*NC*
On-Impoundment Soils	Zinc	RF-ON-3I	209.0	50	500	***4E+00***	4E-01
On-Impoundment Soils	Arsenic	RF-ON-4A	81.0	10	100	***8E+00***	8E-01
On-Impoundment Soils	Lead	RF-ON-4A	1,350.0	50	1000	***3E+01***	1E+00
On-Impoundment Soils	Arsenic	RF-ON-4B	11.0	10	100	1E+00	1E-01
On-Impoundment Soils	Lead	RF-ON-4B	63.0	50	1000	1E+00	6E-02
On-Impoundment Soils	Aluminum	RF-ON-4C	18,900.0	50	NA	***4E+02***	*NC*
On-Impoundment Soils	Antimony	RF-ON-4C	2.5	5	NA	5E-01	*NC*
On-Impoundment Soils	Arsenic	RF-ON-4C	12.5	10	100	1E+00	1E-01
On-Impoundment Soils	Barium	RF-ON-4C	240.0	500	NA	5E-01	*NC*
On-Impoundment Soils	Cadmium	RF-ON-4C	2.5	4	100	6E-01	3E-02

APPENDIX F
Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

* Average concentration across all depths; duplicate/split samples averaged with field samples.

Reach	Parameter	Station ID	Conc (mg/kg)*	Plant Benchmark (mg/kg dw)		Soil HQ	
				Low	High	Low	High
On-Impoundment Soils	Chromium	RF-ON-4C	22.5	1	NA	***2E+01***	***NC***
On-Impoundment Soils	Copper	RF-ON-4C	32.5	100	NA	3E-01	***NC***
On-Impoundment Soils	Lead	RF-ON-4C	111.5	50	1000	***2E+00***	1E-01
On-Impoundment Soils	Mercury	RF-ON-4C	0.5	35	NA	1E-02	***NC***
On-Impoundment Soils	Selenium	RF-ON-4C	2.5	1	NA	***3E+00***	***NC***
On-Impoundment Soils	Silver	RF-ON-4C	2.5	2	NA	1E+00	***NC***
On-Impoundment Soils	Zinc	RF-ON-4C	222.5	50	500	***4E+00***	4E-01
On-Impoundment Soils	Aluminum	RF-ON-4D	21,600.0	50	NA	***4E+02***	***NC***
On-Impoundment Soils	Antimony	RF-ON-4D	2.5	5	NA	5E-01	***NC***
On-Impoundment Soils	Arsenic	RF-ON-4D	6.5	10	100	7E-01	7E-02
On-Impoundment Soils	Barium	RF-ON-4D	327.0	500	NA	7E-01	***NC***
On-Impoundment Soils	Cadmium	RF-ON-4D	0.3	4	100	6E-02	3E-03
On-Impoundment Soils	Chromium	RF-ON-4D	22.5	1	NA	***2E+01***	***NC***
On-Impoundment Soils	Copper	RF-ON-4D	28.0	100	NA	3E-01	***NC***
On-Impoundment Soils	Lead	RF-ON-4D	17.5	50	1000	4E-01	2E-02
On-Impoundment Soils	Mercury	RF-ON-4D	0.1	35	NA	1E-03	***NC***
On-Impoundment Soils	Selenium	RF-ON-4D	2.5	1	NA	***3E+00***	***NC***
On-Impoundment Soils	Silver	RF-ON-4D	2.5	2	NA	1E+00	***NC***
On-Impoundment Soils	Zinc	RF-ON-4D	80.0	50	500	***2E+00***	2E-01
On-Impoundment Soils	Arsenic	RF-ON-4E	7.0	10	100	7E-01	7E-02
On-Impoundment Soils	Lead	RF-ON-4E	20.0	50	1000	4E-01	2E-02
On-Impoundment Soils	Aluminum	RF-ON-4F	21,900.0	50	NA	***4E+02***	***NC***
On-Impoundment Soils	Antimony	RF-ON-4F	2.5	5	NA	5E-01	***NC***
On-Impoundment Soils	Arsenic	RF-ON-4F	6.7	10	100	7E-01	7E-02
On-Impoundment Soils	Barium	RF-ON-4F	218.5	500	NA	4E-01	***NC***
On-Impoundment Soils	Cadmium	RF-ON-4F	0.8	4	100	2E-01	8E-03
On-Impoundment Soils	Chromium	RF-ON-4F	17.0	1	NA	***2E+01***	***NC***
On-Impoundment Soils	Copper	RF-ON-4F	24.7	100	NA	2E-01	***NC***
On-Impoundment Soils	Lead	RF-ON-4F	29.3	50	1000	6E-01	3E-02
On-Impoundment Soils	Mercury	RF-ON-4F	0.1	35	NA	3E-03	***NC***
On-Impoundment Soils	Selenium	RF-ON-4F	2.5	1	NA	***3E+00***	***NC***
On-Impoundment Soils	Silver	RF-ON-4F	2.5	2	NA	1E+00	***NC***
On-Impoundment Soils	Zinc	RF-ON-4F	185.3	50	500	***4E+00***	4E-01
On-Impoundment Soils	Aluminum	RF-ON-4G	26,100.0	50	NA	***5E+02***	***NC***
On-Impoundment Soils	Antimony	RF-ON-4G	2.5	5	NA	5E-01	***NC***
On-Impoundment Soils	Arsenic	RF-ON-4G	6.7	10	100	7E-01	7E-02
On-Impoundment Soils	Cadmium	RF-ON-4G	0.3	4	100	6E-02	3E-03
On-Impoundment Soils	Chromium	RF-ON-4G	20.0	1	NA	***2E+01***	***NC***
On-Impoundment Soils	Copper	RF-ON-4G	38.0	100	NA	4E-01	***NC***
On-Impoundment Soils	Lead	RF-ON-4G	22.7	50	1000	5E-01	2E-02
On-Impoundment Soils	Mercury	RF-ON-4G	0.1	35	NA	1E-03	***NC***
On-Impoundment Soils	Selenium	RF-ON-4G	2.5	1	NA	***3E+00***	***NC***
On-Impoundment Soils	Silver	RF-ON-4G	2.5	2	NA	1E+00	***NC***
On-Impoundment Soils	Zinc	RF-ON-4G	100.0	50	500	***2E+00***	2E-01
On-Impoundment Soils	Aluminum	RF-ON-4H	24,700.0	50	NA	***5E+02***	***NC***
On-Impoundment Soils	Antimony	RF-ON-4H	2.5	5	NA	5E-01	***NC***
On-Impoundment Soils	Arsenic	RF-ON-4H	7.0	10	100	7E-01	7E-02
On-Impoundment Soils	Cadmium	RF-ON-4H	0.3	4	100	6E-02	3E-03
On-Impoundment Soils	Chromium	RF-ON-4H	24.0	1	NA	***2E+01***	***NC***
On-Impoundment Soils	Copper	RF-ON-4H	28.0	100	NA	3E-01	***NC***
On-Impoundment Soils	Lead	RF-ON-4H	29.0	50	1000	6E-01	3E-02
On-Impoundment Soils	Mercury	RF-ON-4H	0.1	35	NA	1E-03	***NC***
On-Impoundment Soils	Selenium	RF-ON-4H	2.5	1	NA	***3E+00***	***NC***
On-Impoundment Soils	Silver	RF-ON-4H	2.5	2	NA	1E+00	***NC***
On-Impoundment Soils	Zinc	RF-ON-4H	115.0	50	500	***2E+00***	2E-01
On-Impoundment Soils	Arsenic	RF-ON-4I	17.0	10	100	***2E+00***	2E-01
On-Impoundment Soils	Lead	RF-ON-4I	344.0	50	1000	***7E+00***	3E-01
On-Impoundment Soils	Arsenic	RF-ON-5A	13.0	10	100	1E+00	1E-01
On-Impoundment Soils	Lead	RF-ON-5A	42.0	50	1000	8E-01	4E-02
On-Impoundment Soils	Aluminum	RF-ON-5B	18,400.0	50	NA	***4E+02***	***NC***
On-Impoundment Soils	Antimony	RF-ON-5B	2.5	5	NA	5E-01	***NC***
On-Impoundment Soils	Arsenic	RF-ON-5B	4.3	10	100	4E-01	4E-02
On-Impoundment Soils	Barium	RF-ON-5B	198.0	500	NA	4E-01	***NC***
On-Impoundment Soils	Cadmium	RF-ON-5B	0.3	4	100	6E-02	3E-03

APPENDIX F
Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

* Average concentration across all depths; duplicate/split samples averaged with field samples.

Reach	Parameter	Station ID	Conc (mg/kg)*	Plant Benchmark (mg/kg dw)		Soil HQ	
				Low	High	Low	High
On-Impoundment Soils	Chromium	RF-ON-5B	20.5	1	NA	***2E+01***	***NC***
On-Impoundment Soils	Copper	RF-ON-5B	23.0	100	NA	2E-01	***NC***
On-Impoundment Soils	Lead	RF-ON-5B	21.5	50	1000	4E-01	2E-02
On-Impoundment Soils	Mercury	RF-ON-5B	0.1	35	NA	1E-03	***NC***
On-Impoundment Soils	Selenium	RF-ON-5B	2.5	1	NA	***3E+00***	***NC***
On-Impoundment Soils	Silver	RF-ON-5B	2.5	2	NA	1E+00	***NC***
On-Impoundment Soils	Zinc	RF-ON-5B	66.0	50	500	1E+00	1E-01
On-Impoundment Soils	Arsenic	RF-ON-5C	15.0	10	100	***2E+00***	2E-01
On-Impoundment Soils	Lead	RF-ON-5C	159.0	50	1000	***3E+00***	2E-01
On-Impoundment Soils	Aluminum	RF-ON-5D	26,100.0	50	NA	***5E+02***	***NC***
On-Impoundment Soils	Antimony	RF-ON-5D	2.5	5	NA	5E-01	***NC***
On-Impoundment Soils	Arsenic	RF-ON-5D	5.0	10	100	5E-01	5E-02
On-Impoundment Soils	Barium	RF-ON-5D	175.0	500	NA	4E-01	***NC***
On-Impoundment Soils	Cadmium	RF-ON-5D	0.3	4	100	6E-02	3E-03
On-Impoundment Soils	Chromium	RF-ON-5D	36.0	1	NA	***4E+01***	***NC***
On-Impoundment Soils	Copper	RF-ON-5D	26.0	100	NA	3E-01	***NC***
On-Impoundment Soils	Lead	RF-ON-5D	23.0	50	1000	5E-01	2E-02
On-Impoundment Soils	Mercury	RF-ON-5D	0.1	35	NA	1E-03	***NC***
On-Impoundment Soils	Selenium	RF-ON-5D	2.5	1	NA	***3E+00***	***NC***
On-Impoundment Soils	Silver	RF-ON-5D	2.5	2	NA	1E+00	***NC***
On-Impoundment Soils	Zinc	RF-ON-5D	87.5	50	500	***2E+00***	2E-01
On-Impoundment Soils	Arsenic	RF-ON-5E	2.5	10	100	3E-01	3E-02
On-Impoundment Soils	Lead	RF-ON-5E	15.0	50	1000	3E-01	2E-02
On-Impoundment Soils	Arsenic	RF-ON-5F	12.0	10	100	1E+00	1E-01
On-Impoundment Soils	Lead	RF-ON-5F	25.0	50	1000	5E-01	3E-02
On-Impoundment Soils	Arsenic	RF-ON-5G	20.0	10	100	***2E+00***	2E-01
On-Impoundment Soils	Lead	RF-ON-5G	333.0	50	1000	***7E+00***	3E-01
On-Impoundment Soils	Arsenic	RF-ON-5H	9.2	10	100	9E-01	9E-02
On-Impoundment Soils	Lead	RF-ON-5H	52.0	50	1000	1E+00	5E-02
On-Impoundment Soils	Arsenic	RF-ON-6D	17.0	10	100	***2E+00***	2E-01
On-Impoundment Soils	Lead	RF-ON-6D	135.0	50	1000	***3E+00***	1E-01
Site Tailings	Aluminum	RF-TA-TP1	2,260.0	50	NA	***5E+01***	***NC***
Site Tailings	Antimony	RF-TA-TP1	50.7	5	NA	***1E+01***	***NC***
Site Tailings	Arsenic	RF-TA-TP1	219.0	10	100	***2E+01***	***2E+00***
Site Tailings	Cadmium	RF-TA-TP1	27.3	4	100	***7E+00***	3E-01
Site Tailings	Chromium	RF-TA-TP1	8.6	1	NA	***9E+00***	***NC***
Site Tailings	Copper	RF-TA-TP1	522.2	100	NA	***5E+00***	***NC***
Site Tailings	Lead	RF-TA-TP1	4,328.3	50	1000	***9E+01***	***4E+00***
Site Tailings	Mercury	RF-TA-TP1	0.5	35	NA	1E-02	***NC***
Site Tailings	Selenium	RF-TA-TP1	4.7	1	NA	***5E+00***	***NC***
Site Tailings	Silver	RF-TA-TP1	18.5	2	NA	***9E+00***	***NC***
Site Tailings	Zinc	RF-TA-TP1	5,136.7	50	500	***1E+02***	***1E+01***
Site Tailings	Aluminum	RF-TA-TP2	3,986.7	50	NA	***8E+01***	***NC***
Site Tailings	Antimony	RF-TA-TP2	174.9	5	NA	***3E+01***	***NC***
Site Tailings	Arsenic	RF-TA-TP2	308.9	10	100	***3E+01***	***3E+00***
Site Tailings	Cadmium	RF-TA-TP2	42.6	4	100	***1E+01***	4E-01
Site Tailings	Chromium	RF-TA-TP2	30.3	1	NA	***3E+01***	***NC***
Site Tailings	Copper	RF-TA-TP2	475.1	100	NA	***5E+00***	***NC***
Site Tailings	Lead	RF-TA-TP2	5,508.3	50	1000	***1E+02***	***6E+00***
Site Tailings	Mercury	RF-TA-TP2	4.0	35	NA	1E-01	***NC***
Site Tailings	Selenium	RF-TA-TP2	10.7	1	NA	***1E+01***	***NC***
Site Tailings	Silver	RF-TA-TP2	40.8	2	NA	***2E+01***	***NC***
Site Tailings	Zinc	RF-TA-TP2	7,190.8	50	500	***1E+02***	***1E+01***
Site Tailings	Aluminum	RF-TA-TP3	1,987.2	50	NA	***4E+01***	***NC***
Site Tailings	Antimony	RF-TA-TP3	107.7	5	NA	***2E+01***	***NC***
Site Tailings	Arsenic	RF-TA-TP3	224.3	10	100	***2E+01***	***2E+00***
Site Tailings	Cadmium	RF-TA-TP3	33.8	4	100	***8E+00***	3E-01
Site Tailings	Chromium	RF-TA-TP3	18.2	1	NA	***2E+01***	***NC***
Site Tailings	Copper	RF-TA-TP3	253.5	100	NA	***3E+00***	***NC***
Site Tailings	Lead	RF-TA-TP3	3,796.7	50	1000	***8E+01***	***4E+00***
Site Tailings	Mercury	RF-TA-TP3	16.0	35	NA	5E-01	***NC***
Site Tailings	Selenium	RF-TA-TP3	11.3	1	NA	***1E+01***	***NC***
Site Tailings	Silver	RF-TA-TP3	23.8	2	NA	***1E+01***	***NC***
Site Tailings	Zinc	RF-TA-TP3	5,865.0	50	500	***1E+02***	***1E+01***

APPENDIX F
Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

* Average concentration across all depths: duplicate/split samples averaged with field samples.

Reach	Parameter	Station ID	Conc (mg/kg)*	Plant Benchmark (mg/kg dw)		Soil HQ	
				Low	High	Low	High
Site Tailings	Aluminum	RF-TSDD-GL50	13,377.8	50	NA	3E+02	NC
Site Tailings	Antimony	RF-TSDD-GL50	125.5	5	NA	3E+01	NC
Site Tailings	Arsenic	RF-TSDD-GL50	197.4	10	100	2E+01	2E+00
Site Tailings	Cadmium	RF-TSDD-GL50	28.8	4	100	7E+00	3E-01
Site Tailings	Chromium	RF-TSDD-GL50	22.5	1	NA	2E+01	NC
Site Tailings	Copper	RF-TSDD-GL50	311.3	100	NA	3E+00	NC
Site Tailings	Lead	RF-TSDD-GL50	4,059.8	50	1000	8E+01	4E+00
Site Tailings	Mercury	RF-TSDD-GL50	2.8	35	NA	8E-02	NC
Site Tailings	Selenium	RF-TSDD-GL50	4.1	1	NA	4E+00	NC
Site Tailings	Silver	RF-TSDD-GL50	26.0	2	NA	1E+01	NC
Site Tailings	Zinc	RF-TSDD-GL50	5,728.8	50	500	1E+02	1E+01
Site Tailings	Aluminum	RF-TSDD-GL52	14,027.0	50	NA	3E+02	NC
Site Tailings	Antimony	RF-TSDD-GL52	253.8	5	NA	5E+01	NC
Site Tailings	Arsenic	RF-TSDD-GL52	321.8	10	100	3E+01	3E+00
Site Tailings	Cadmium	RF-TSDD-GL52	51.1	4	100	1E+01	5E-01
Site Tailings	Chromium	RF-TSDD-GL52	27.5	1	NA	3E+01	NC
Site Tailings	Copper	RF-TSDD-GL52	620.0	100	NA	6E+00	NC
Site Tailings	Lead	RF-TSDD-GL52	10,699.5	50	1000	2E+02	1E+01
Site Tailings	Mercury	RF-TSDD-GL52	5.5	35	NA	2E-01	NC
Site Tailings	Selenium	RF-TSDD-GL52	11.3	1	NA	1E+01	NC
Site Tailings	Silver	RF-TSDD-GL52	39.8	2	NA	2E+01	NC
Site Tailings	Zinc	RF-TSDD-GL52	7,818.5	50	500	2E+02	2E+01
Site Tailings	Aluminum	RF-TSDD-GL53	16,151.5	50	NA	3E+02	NC
Site Tailings	Antimony	RF-TSDD-GL53	212.8	5	NA	4E+01	NC
Site Tailings	Arsenic	RF-TSDD-GL53	319.7	10	100	3E+01	3E+00
Site Tailings	Cadmium	RF-TSDD-GL53	56.9	4	100	1E+01	6E-01
Site Tailings	Chromium	RF-TSDD-GL53	29.5	1	NA	3E+01	NC
Site Tailings	Copper	RF-TSDD-GL53	678.5	100	NA	7E+00	NC
Site Tailings	Lead	RF-TSDD-GL53	10,533.5	50	1000	2E+02	1E+01
Site Tailings	Mercury	RF-TSDD-GL53	10.6	35	NA	3E-01	NC
Site Tailings	Selenium	RF-TSDD-GL53	13.3	1	NA	1E+01	NC
Site Tailings	Silver	RF-TSDD-GL53	61.3	2	NA	3E+01	NC
Site Tailings	Zinc	RF-TSDD-GL53	9,420.0	50	500	2E+02	2E+01
Site Tailings	Aluminum	RF-TSDD-GL56	11,442.5	50	NA	2E+02	NC
Site Tailings	Antimony	RF-TSDD-GL56	89.2	5	NA	2E+01	NC
Site Tailings	Arsenic	RF-TSDD-GL56	136.3	10	100	1E+01	1E+00
Site Tailings	Cadmium	RF-TSDD-GL56	23.3	4	100	6E+00	2E-01
Site Tailings	Chromium	RF-TSDD-GL56	21.5	1	NA	2E+01	NC
Site Tailings	Copper	RF-TSDD-GL56	247.5	100	NA	2E+00	NC
Site Tailings	Lead	RF-TSDD-GL56	2,897.5	50	1000	6E+01	3E+00
Site Tailings	Mercury	RF-TSDD-GL56	1.8	35	NA	5E-02	NC
Site Tailings	Selenium	RF-TSDD-GL56	2.5	1	NA	3E+00	NC
Site Tailings	Silver	RF-TSDD-GL56	20.3	2	NA	1E+01	NC
Site Tailings	Zinc	RF-TSDD-GL56	4,518.5	50	500	9E+01	9E+00
Site Tailings	Aluminum	RF-TSDD-GL58	14,787.5	50	NA	3E+02	NC
Site Tailings	Antimony	RF-TSDD-GL58	58.3	5	NA	1E+01	NC
Site Tailings	Arsenic	RF-TSDD-GL58	144.0	10	100	1E+01	1E+00
Site Tailings	Cadmium	RF-TSDD-GL58	22.7	4	100	6E+00	2E-01
Site Tailings	Chromium	RF-TSDD-GL58	21.0	1	NA	2E+01	NC
Site Tailings	Copper	RF-TSDD-GL58	168.5	100	NA	2E+00	NC
Site Tailings	Lead	RF-TSDD-GL58	2,622.0	50	1000	5E+01	3E+00
Site Tailings	Mercury	RF-TSDD-GL58	2.6	35	NA	7E-02	NC
Site Tailings	Selenium	RF-TSDD-GL58	11.3	1	NA	1E+01	NC
Site Tailings	Silver	RF-TSDD-GL58	15.3	2	NA	8E+00	NC
Site Tailings	Zinc	RF-TSDD-GL58	3,378.0	50	500	7E+01	7E+00
Site Tailings	Aluminum	RF-TSDD-GL59	13,622.0	50	NA	3E+02	NC
Site Tailings	Antimony	RF-TSDD-GL59	168.3	5	NA	3E+01	NC
Site Tailings	Arsenic	RF-TSDD-GL59	219.0	10	100	2E+01	2E+00
Site Tailings	Cadmium	RF-TSDD-GL59	24.0	4	100	6E+00	2E-01
Site Tailings	Chromium	RF-TSDD-GL59	24.0	1	NA	2E+01	NC
Site Tailings	Copper	RF-TSDD-GL59	418.5	100	NA	4E+00	NC
Site Tailings	Lead	RF-TSDD-GL59	3,834.5	50	1000	8E+01	4E+00
Site Tailings	Mercury	RF-TSDD-GL59	13.6	35	NA	4E-01	NC
Site Tailings	Selenium	RF-TSDD-GL59	6.1	1	NA	6E+00	NC

APPENDIX F

Plant Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Richardson Flat Tailings Site

Screening Ecological Risk Assessment

* Average concentration across all depths; duplicate/split samples averaged with field samples.

Reach	Parameter	Station ID	Conc (mg/kg)*	Plant Benchmark (mg/kg dw)		Soil HQ	
				Low	High	Low	High
Site Tailings	Silver	RF-TSDD-GL59	22.8	2	NA	*1E+01*	*NC*
Site Tailings	Zinc	RF-TSDD-GL59	5,462.0	50	500	*1E+02*	*1E+01*
Site Tailings	Aluminum	RF-TSDD-GL62	17,379.5	50	NA	*3E+02*	*NC*
Site Tailings	Antimony	RF-TSDD-GL62	45.3	5	NA	*9E+00*	*NC*
Site Tailings	Arsenic	RF-TSDD-GL62	99.6	10	100	*1E+01*	1E+00
Site Tailings	Cadmium	RF-TSDD-GL62	20.1	4	100	*5E+00*	2E-01
Site Tailings	Chromium	RF-TSDD-GL62	22.5	1	NA	*2E+01*	*NC*
Site Tailings	Copper	RF-TSDD-GL62	126.5	100	NA	1E+00	*NC*
Site Tailings	Lead	RF-TSDD-GL62	1,572.0	50	1000	*3E+01*	*2E+00*
Site Tailings	Mercury	RF-TSDD-GL62	0.7	35	NA	2E-02	*NC*
Site Tailings	Selenium	RF-TSDD-GL62	5.9	1	NA	*6E+00*	*NC*
Site Tailings	Silver	RF-TSDD-GL62	11.3	2	NA	*6E+00*	*NC*
Site Tailings	Zinc	RF-TSDD-GL62	2,981.0	50	500	*6E+01*	*6E+00*

APPENDIX G

CALCULATION OF HAZARDS FOR SOIL FAUNA FROM DIRECT CONTACT WITH SOILS/TAILINGS

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APPENDIX G
Soil Invertebrate Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

* Average concentration across all depths; duplicate/split samples averaged with field samples.

				Soil Invertebrate Benchmark (mg/kg dw)		Soil HQ	
Reach	Station ID	Parameter	Conc* (mg/kg)	Low	High	Low	High
Background Soils	RF-BG-BG1	Arsenic	11.0	20	100	6E-01	1E-01
Background Soils	RF-BG-BG1	Lead	47.0	140	900	3E-01	5E-02
Background Soils	RF-BG-BG10	Arsenic	7.0	20	100	4E-01	7E-02
Background Soils	RF-BG-BG10	Barium	220.0	3000	NA	7E-02	**NC**
Background Soils	RF-BG-BG10	Cadmium	0.3	1.6	20	2E-01	1E-02
Background Soils	RF-BG-BG10	Chromium	22.5	0.4	100	**6E+01**	2E-01
Background Soils	RF-BG-BG10	Copper	15.5	40	150	4E-01	1E-01
Background Soils	RF-BG-BG10	Lead	30.5	140	900	2E-01	3E-02
Background Soils	RF-BG-BG10	Mercury	0.1	0.1	30	5E-01	2E-03
Background Soils	RF-BG-BG10	Selenium	2.5	2	100	1E+00	3E-02
Background Soils	RF-BG-BG10	Silver	2.5	50	NA	5E-02	**NC**
Background Soils	RF-BG-BG10	Zinc	93.0	100	600	9E-01	2E-01
Background Soils	RF-BG-BG2	Arsenic	8.1	20	100	4E-01	8E-02
Background Soils	RF-BG-BG2	Lead	26.0	140	900	2E-01	3E-02
Background Soils	RF-BG-BG3	Arsenic	8.6	20	100	4E-01	9E-02
Background Soils	RF-BG-BG3	Lead	22.0	140	900	2E-01	2E-02
Background Soils	RF-BG-BG4	Arsenic	9.2	20	100	5E-01	9E-02
Background Soils	RF-BG-BG4	Lead	25.0	140	900	2E-01	3E-02
Background Soils	RF-BG-BG5	Arsenic	11.0	20	100	6E-01	1E-01
Background Soils	RF-BG-BG5	Lead	43.0	140	900	3E-01	5E-02
Background Soils	RF-BG-BG6	Arsenic	7.0	20	100	4E-01	7E-02
Background Soils	RF-BG-BG6	Lead	30.0	140	900	2E-01	3E-02
Background Soils	RF-BG-BG7	Arsenic	6.9	20	100	3E-01	7E-02
Background Soils	RF-BG-BG7	Lead	25.0	140	900	2E-01	3E-02
Background Soils	RF-BG-BG8	Arsenic	14.0	20	100	7E-01	1E-01
Background Soils	RF-BG-BG8	Barium	265.0	3000	NA	9E-02	**NC**
Background Soils	RF-BG-BG8	Cadmium	1.0	1.6	20	6E-01	5E-02
Background Soils	RF-BG-BG8	Chromium	20.0	0.4	100	**5E+01**	2E-01
Background Soils	RF-BG-BG8	Copper	29.0	40	150	7E-01	2E-01
Background Soils	RF-BG-BG8	Lead	84.0	140	900	6E-01	9E-02
Background Soils	RF-BG-BG8	Mercury	0.2	0.1	30	**2E+00**	5E-03
Background Soils	RF-BG-BG8	Selenium	2.5	2	100	1E+00	3E-02
Background Soils	RF-BG-BG8	Silver	2.5	50	NA	5E-02	**NC**
Background Soils	RF-BG-BG8	Zinc	127.0	100	600	1E+00	2E-01
Background Soils	RF-BG-BG9	Arsenic	6.7	20	100	3E-01	7E-02
Background Soils	RF-BG-BG9	Lead	98.0	140	900	7E-01	1E-01
Off-Impoundment Soils	RF-OF-T1A	Arsenic	26.0	20	100	1E+00	3E-01
Off-Impoundment Soils	RF-OF-T1A	Lead	470.5	140	900	**3E+00**	5E-01
Off-Impoundment Soils	RF-OF-T1B	Arsenic	11.0	20	100	6E-01	1E-01
Off-Impoundment Soils	RF-OF-T1B	Lead	101.0	140	900	7E-01	1E-01
Off-Impoundment Soils	RF-OF-T1C	Arsenic	8.5	20	100	4E-01	9E-02
Off-Impoundment Soils	RF-OF-T1C	Barium	193.5	3000	NA	6E-02	**NC**
Off-Impoundment Soils	RF-OF-T1C	Cadmium	1.0	1.6	20	6E-01	5E-02
Off-Impoundment Soils	RF-OF-T1C	Chromium	21.5	0.4	100	**5E+01**	2E-01
Off-Impoundment Soils	RF-OF-T1C	Copper	24.0	40	150	6E-01	2E-01
Off-Impoundment Soils	RF-OF-T1C	Lead	77.0	140	900	6E-01	9E-02
Off-Impoundment Soils	RF-OF-T1C	Mercury	0.1	0.1	30	5E-01	2E-03
Off-Impoundment Soils	RF-OF-T1C	Selenium	2.5	2	100	1E+00	3E-02
Off-Impoundment Soils	RF-OF-T1C	Silver	2.5	50	NA	5E-02	**NC**
Off-Impoundment Soils	RF-OF-T1C	Zinc	145.0	100	600	1E+00	2E-01
Off-Impoundment Soils	RF-OF-T1D	Arsenic	8.5	20	100	4E-01	8E-02
Off-Impoundment Soils	RF-OF-T1D	Lead	76.0	140	900	5E-01	8E-02
Off-Impoundment Soils	RF-OF-T1E	Arsenic	9.1	20	100	5E-01	9E-02
Off-Impoundment Soils	RF-OF-T1E	Lead	53.3	140	900	4E-01	6E-02
Off-Impoundment Soils	RF-OF-T1F	Arsenic	10.5	20	100	5E-01	1E-01
Off-Impoundment Soils	RF-OF-T1F	Lead	64.5	140	900	5E-01	7E-02
Off-Impoundment Soils	RF-OF-T1G	Arsenic	9.2	20	100	5E-01	9E-02
Off-Impoundment Soils	RF-OF-T1G	Lead	46.5	140	900	3E-01	5E-02

Soil Invertebrate Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

* Average concentration across all depths; duplicate/split samples averaged with field samples.

Reach	Station ID	Parameter	Conc* (mg/kg)	Soil Invertebrate Benchmark (mg/kg dw)		Soil HQ	
				Low	High	Low	High
Off-Impoundment Soils	RF-OF-T1H	Arsenic	10.0	20	100	5E-01	1E-01
Off-Impoundment Soils	RF-OF-T1H	Lead	32.5	140	900	2E-01	4E-02
Off-Impoundment Soils	RF-OF-T2A	Arsenic	37.0	20	100	**2E+00**	4E-01
Off-Impoundment Soils	RF-OF-T2A	Lead	471.0	140	900	**3E+00**	5E-01
Off-Impoundment Soils	RF-OF-T2B	Arsenic	13.0	20	100	7E-01	1E-01
Off-Impoundment Soils	RF-OF-T2B	Lead	120.5	140	900	9E-01	1E-01
Off-Impoundment Soils	RF-OF-T2C	Arsenic	129.0	20	100	**6E+00**	1E+00
Off-Impoundment Soils	RF-OF-T2C	Lead	3,308.0	140	900	**2E+01**	**4E+00**
Off-Impoundment Soils	RF-OF-T2D	Arsenic	279.5	20	100	**1E+01**	**3E+00**
Off-Impoundment Soils	RF-OF-T2D	Lead	6,070.0	140	900	**4E+01**	**7E+00**
Off-Impoundment Soils	RF-OF-T2E	Arsenic	245.5	20	100	**1E+01**	**2E+00**
Off-Impoundment Soils	RF-OF-T2E	Lead	5,179.5	140	900	**4E+01**	**6E+00**
Off-Impoundment Soils	RF-OF-T2F	Arsenic	11.3	20	100	6E-01	1E-01
Off-Impoundment Soils	RF-OF-T2F	Barium	233.8	3000	NA	8E-02	**NC**
Off-Impoundment Soils	RF-OF-T2F	Cadmium	0.9	1.6	20	5E-01	4E-02
Off-Impoundment Soils	RF-OF-T2F	Chromium	21.5	0.4	100	**5E+01**	2E-01
Off-Impoundment Soils	RF-OF-T2F	Copper	30.3	40	150	8E-01	2E-01
Off-Impoundment Soils	RF-OF-T2F	Lead	112.5	140	900	8E-01	1E-01
Off-Impoundment Soils	RF-OF-T2F	Mercury	0.1	0.1	30	5E-01	2E-03
Off-Impoundment Soils	RF-OF-T2F	Selenium	2.5	2	100	1E+00	3E-02
Off-Impoundment Soils	RF-OF-T2F	Silver	2.5	50	NA	5E-02	**NC**
Off-Impoundment Soils	RF-OF-T2F	Zinc	178.3	100	600	**2E+00**	3E-01
Off-Impoundment Soils	RF-OF-T2G	Arsenic	7.6	20	100	4E-01	8E-02
Off-Impoundment Soils	RF-OF-T2G	Lead	19.5	140	900	1E-01	2E-02
Off-Impoundment Soils	RF-OF-T2H	Arsenic	8.0	20	100	4E-01	8E-02
Off-Impoundment Soils	RF-OF-T2H	Barium	303.0	3000	NA	1E-01	**NC**
Off-Impoundment Soils	RF-OF-T2H	Cadmium	0.6	1.6	20	4E-01	3E-02
Off-Impoundment Soils	RF-OF-T2H	Chromium	30.5	0.4	100	**8E+01**	3E-01
Off-Impoundment Soils	RF-OF-T2H	Copper	24.0	40	150	6E-01	2E-01
Off-Impoundment Soils	RF-OF-T2H	Lead	48.0	140	900	3E-01	5E-02
Off-Impoundment Soils	RF-OF-T2H	Mercury	0.1	0.1	30	5E-01	2E-03
Off-Impoundment Soils	RF-OF-T2H	Selenium	2.5	2	100	1E+00	3E-02
Off-Impoundment Soils	RF-OF-T2H	Silver	2.5	50	NA	5E-02	**NC**
Off-Impoundment Soils	RF-OF-T2H	Zinc	93.0	100	600	9E-01	2E-01
Off-Impoundment Soils	RF-OF-T2I	Arsenic	7.4	20	100	4E-01	7E-02
Off-Impoundment Soils	RF-OF-T2I	Lead	46.5	140	900	3E-01	5E-02
Off-Impoundment Soils	RF-OF-T2J	Arsenic	8.5	20	100	4E-01	9E-02
Off-Impoundment Soils	RF-OF-T2J	Lead	39.5	140	900	3E-01	4E-02
Off-Impoundment Soils	RF-OF-T3A	Arsenic	9.3	20	100	5E-01	9E-02
Off-Impoundment Soils	RF-OF-T3A	Lead	55.0	140	900	4E-01	6E-02
Off-Impoundment Soils	RF-OF-T3B	Arsenic	37.0	20	100	**2E+00**	4E-01
Off-Impoundment Soils	RF-OF-T3B	Barium	225.5	3000	NA	8E-02	**NC**
Off-Impoundment Soils	RF-OF-T3B	Cadmium	29.5	1.6	20	**2E+01**	1E+00
Off-Impoundment Soils	RF-OF-T3B	Chromium	20.5	0.4	100	**5E+01**	2E-01
Off-Impoundment Soils	RF-OF-T3B	Copper	89.5	40	150	**2E+00**	6E-01
Off-Impoundment Soils	RF-OF-T3B	Lead	812.5	140	900	**6E+00**	9E-01
Off-Impoundment Soils	RF-OF-T3B	Mercury	3.1	0.1	30	**3E+01**	1E-01
Off-Impoundment Soils	RF-OF-T3B	Selenium	2.5	2	100	1E+00	3E-02
Off-Impoundment Soils	RF-OF-T3B	Silver	2.5	50	NA	5E-02	**NC**
Off-Impoundment Soils	RF-OF-T3B	Zinc	1,366.5	100	600	**1E+01**	**2E+00**
Off-Impoundment Soils	RF-OF-T3C	Arsenic	8.6	20	100	4E-01	9E-02
Off-Impoundment Soils	RF-OF-T3C	Lead	53.5	140	900	4E-01	6E-02
Off-Impoundment Soils	RF-OF-T3D	Arsenic	7.5	20	100	4E-01	8E-02
Off-Impoundment Soils	RF-OF-T3D	Barium	403.0	3000	NA	1E-01	**NC**
Off-Impoundment Soils	RF-OF-T3D	Cadmium	1.0	1.6	20	6E-01	5E-02
Off-Impoundment Soils	RF-OF-T3D	Chromium	21.3	0.4	100	**5E+01**	2E-01
Off-Impoundment Soils	RF-OF-T3D	Copper	33.3	40	150	8E-01	2E-01
Off-Impoundment Soils	RF-OF-T3D	Lead	53.5	140	900	4E-01	6E-02
Off-Impoundment Soils	RF-OF-T3D	Mercury	0.1	0.1	30	8E-01	3E-03

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Soil Invertebrate Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

* Average concentration across all depths; duplicate/split samples averaged with field samples.

Reach	Station ID	Parameter	Conc* (mg/kg)	Soil Invertebrate Benchmark (mg/kg dw)		Soil HQ	
				Low	High	Low	High
Off-Impoundment Soils	RF-OF-T3D	Selenium	2.5	2	100	1E+00	3E-02
Off-Impoundment Soils	RF-OF-T3D	Silver	2.5	50	NA	5E-02	**NC**
Off-Impoundment Soils	RF-OF-T3D	Zinc	138.3	100	600	1E+00	2E-01
Off-Impoundment Soils	RF-OF-T3E	Arsenic	6.7	20	100	3E-01	7E-02
Off-Impoundment Soils	RF-OF-T3E	Lead	17.5	140	900	1E-01	2E-02
Off-Impoundment Soils	RF-OF-T3F	Arsenic	7.5	20	100	4E-01	7E-02
Off-Impoundment Soils	RF-OF-T3F	Lead	19.0	140	900	1E-01	2E-02
Off-Impoundment Soils	RF-OF-T3G	Arsenic	6.5	20	100	3E-01	7E-02
Off-Impoundment Soils	RF-OF-T3G	Lead	27.5	140	900	2E-01	3E-02
Off-Impoundment Soils	RF-OF-T3H	Arsenic	7.0	20	100	3E-01	7E-02
Off-Impoundment Soils	RF-OF-T3H	Lead	27.0	140	900	2E-01	3E-02
Off-Impoundment Soils	RF-OF-T3I	Arsenic	9.2	20	100	5E-01	9E-02
Off-Impoundment Soils	RF-OF-T3I	Lead	25.0	140	900	2E-01	3E-02
Off-Impoundment Soils	RF-OF-T3J	Arsenic	9.2	20	100	5E-01	9E-02
Off-Impoundment Soils	RF-OF-T3J	Lead	47.0	140	900	3E-01	5E-02
Off-Impoundment Soils	SAB-1	Arsenic	12.0	20	100	6E-01	1E-01
Off-Impoundment Soils	SAB-1	Lead	98.0	140	900	7E-01	1E-01
Off-Impoundment Soils	SAB-2	Arsenic	14.0	20	100	7E-01	1E-01
Off-Impoundment Soils	SAB-2	Lead	135.0	140	900	1E+00	2E-01
Off-Impoundment Soils	SAB-3	Arsenic	11.0	20	100	6E-01	1E-01
Off-Impoundment Soils	SAB-3	Lead	75.0	140	900	5E-01	8E-02
Off-Impoundment Soils	SAB-4	Arsenic	12.0	20	100	6E-01	1E-01
Off-Impoundment Soils	SAB-4	Lead	144.0	140	900	1E+00	2E-01
Off-Impoundment Soils	SAB-5	Arsenic	12.0	20	100	6E-01	1E-01
Off-Impoundment Soils	SAB-5	Lead	53.0	140	900	4E-01	6E-02
Off-Impoundment Soils	SAB-7	Arsenic	30.0	20	100	**2E+00**	3E-01
Off-Impoundment Soils	SAB-7	Lead	165.0	140	900	1E+00	2E-01
Off-Impoundment Soils	SAB-8	Arsenic	23.0	20	100	1E+00	2E-01
Off-Impoundment Soils	SAB-8	Lead	63.0	140	900	5E-01	7E-02
On-Impoundment Soils	RF-ON-1A	Arsenic	15.0	20	100	8E-01	2E-01
On-Impoundment Soils	RF-ON-1A	Lead	37.0	140	900	3E-01	4E-02
On-Impoundment Soils	RF-ON-1B	Arsenic	9.1	20	100	5E-01	9E-02
On-Impoundment Soils	RF-ON-1B	Lead	44.0	140	900	3E-01	5E-02
On-Impoundment Soils	RF-ON-1C	Arsenic	12.0	20	100	6E-01	1E-01
On-Impoundment Soils	RF-ON-1C	Lead	163.0	140	900	1E+00	2E-01
On-Impoundment Soils	RF-ON-1D	Arsenic	10.0	20	100	5E-01	1E-01
On-Impoundment Soils	RF-ON-1D	Lead	96.0	140	900	7E-01	1E-01
On-Impoundment Soils	RF-ON-1E	Arsenic	20.0	20	100	1E+00	2E-01
On-Impoundment Soils	RF-ON-1E	Lead	336.0	140	900	**2E+00**	4E-01
On-Impoundment Soils	RF-ON-1G	Arsenic	121.0	20	100	**6E+00**	1E+00
On-Impoundment Soils	RF-ON-1G	Lead	3,239.0	140	900	**2E+01**	**4E+00**
On-Impoundment Soils	RF-ON-2A	Arsenic	13.0	20	100	7E-01	1E-01
On-Impoundment Soils	RF-ON-2A	Lead	49.0	140	900	4E-01	5E-02
On-Impoundment Soils	RF-ON-2B	Arsenic	78.0	20	100	**4E+00**	8E-01
On-Impoundment Soils	RF-ON-2B	Lead	1,155.0	140	900	**8E+00**	1E+00
On-Impoundment Soils	RF-ON-2C	Arsenic	7.8	20	100	4E-01	8E-02
On-Impoundment Soils	RF-ON-2C	Lead	19.0	140	900	1E-01	2E-02
On-Impoundment Soils	RF-ON-2D	Arsenic	6.8	20	100	3E-01	7E-02
On-Impoundment Soils	RF-ON-2D	Lead	19.5	140	900	1E-01	2E-02
On-Impoundment Soils	RF-ON-2E	Arsenic	44.0	20	100	**2E+00**	4E-01
On-Impoundment Soils	RF-ON-2E	Lead	904.5	140	900	**6E+00**	1E+00
On-Impoundment Soils	RF-ON-2F	Arsenic	82.0	20	100	**4E+00**	8E-01
On-Impoundment Soils	RF-ON-2F	Lead	2,646.0	140	900	**2E+01**	**3E+00**
On-Impoundment Soils	RF-ON-2G	Arsenic	12.0	20	100	6E-01	1E-01
On-Impoundment Soils	RF-ON-2G	Lead	59.0	140	900	4E-01	7E-02
On-Impoundment Soils	RF-ON-2H	Aluminum	22,600.0	600	NA	**4E+01**	**NC**
On-Impoundment Soils	RF-ON-2H	Antimony	2.5	NA	NA	**NC**	**NC**
On-Impoundment Soils	RF-ON-2H	Arsenic	3.7	20	100	2E-01	4E-02
On-Impoundment Soils	RF-ON-2H	Barium	206.0	3000	NA	7E-02	**NC**

Soil Invertebrate Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

* Average concentration across all depths; duplicate/split samples averaged with field samples.

Reach	Station ID	Parameter	Conc* (mg/kg)	Soil Invertebrate Benchmark (mg/kg dw)		Soil HQ	
				Low	High	Low	High
On-Impoundment Soils	RF-ON-2H	Cadmium	0.5	1.6	20	3E-01	3E-02
On-Impoundment Soils	RF-ON-2H	Chromium	22.3	0.4	100	**6E+01**	2E-01
On-Impoundment Soils	RF-ON-2H	Copper	15.0	40	150	4E-01	1E-01
On-Impoundment Soils	RF-ON-2H	Lead	25.3	140	900	2E-01	3E-02
On-Impoundment Soils	RF-ON-2H	Mercury	0.1	0.1	30	5E-01	2E-03
On-Impoundment Soils	RF-ON-2H	Selenium	2.5	2	100	1E+00	3E-02
On-Impoundment Soils	RF-ON-2H	Silver	2.5	50	NA	5E-02	**NC**
On-Impoundment Soils	RF-ON-2H	Zinc	91.3	100	600	9E-01	2E-01
On-Impoundment Soils	RF-ON-3A	Arsenic	49.0	20	100	**2E+00**	5E-01
On-Impoundment Soils	RF-ON-3A	Barium	210.0	3000	NA	7E-02	**NC**
On-Impoundment Soils	RF-ON-3A	Cadmium	6.0	1.6	20	**4E+00**	3E-01
On-Impoundment Soils	RF-ON-3A	Chromium	24.0	0.4	100	**6E+01**	2E-01
On-Impoundment Soils	RF-ON-3A	Copper	99.0	40	150	**2E+00**	7E-01
On-Impoundment Soils	RF-ON-3A	Lead	875.0	140	900	**6E+00**	1E+00
On-Impoundment Soils	RF-ON-3A	Mercury	0.7	0.1	30	**7E+00**	2E-02
On-Impoundment Soils	RF-ON-3A	Selenium	2.5	2	100	1E+00	3E-02
On-Impoundment Soils	RF-ON-3A	Silver	2.5	50	NA	5E-02	**NC**
On-Impoundment Soils	RF-ON-3A	Zinc	1,010.0	100	600	**1E+01**	**2E+00**
On-Impoundment Soils	RF-ON-3B	Aluminum	22,400.0	600	NA	**4E+01**	**NC**
On-Impoundment Soils	RF-ON-3B	Antimony	2.5	NA	NA	**NC**	**NC**
On-Impoundment Soils	RF-ON-3B	Arsenic	36.0	20	100	**2E+00**	4E-01
On-Impoundment Soils	RF-ON-3B	Cadmium	1.0	1.6	20	6E-01	5E-02
On-Impoundment Soils	RF-ON-3B	Chromium	20.0	0.4	100	**5E+01**	2E-01
On-Impoundment Soils	RF-ON-3B	Copper	53.0	40	150	1E+00	4E-01
On-Impoundment Soils	RF-ON-3B	Lead	528.5	140	900	**4E+00**	6E-01
On-Impoundment Soils	RF-ON-3B	Mercury	0.2	0.1	30	**2E+00**	5E-03
On-Impoundment Soils	RF-ON-3B	Selenium	2.5	2	100	1E+00	3E-02
On-Impoundment Soils	RF-ON-3B	Silver	2.5	50	NA	5E-02	**NC**
On-Impoundment Soils	RF-ON-3B	Zinc	242.0	100	600	**2E+00**	4E-01
On-Impoundment Soils	RF-ON-3C	Arsenic	6.2	20	100	3E-01	6E-02
On-Impoundment Soils	RF-ON-3C	Lead	15.0	140	900	1E-01	2E-02
On-Impoundment Soils	RF-ON-3D	Aluminum	17,600.0	600	NA	**3E+01**	**NC**
On-Impoundment Soils	RF-ON-3D	Antimony	10.0	NA	NA	**NC**	**NC**
On-Impoundment Soils	RF-ON-3D	Arsenic	46.0	20	100	**2E+00**	5E-01
On-Impoundment Soils	RF-ON-3D	Barium	255.0	3000	NA	9E-02	**NC**
On-Impoundment Soils	RF-ON-3D	Cadmium	3.5	1.6	20	**2E+00**	2E-01
On-Impoundment Soils	RF-ON-3D	Chromium	24.5	0.4	100	**6E+01**	2E-01
On-Impoundment Soils	RF-ON-3D	Copper	84.5	40	150	**2E+00**	6E-01
On-Impoundment Soils	RF-ON-3D	Lead	574.5	140	900	**4E+00**	6E-01
On-Impoundment Soils	RF-ON-3D	Mercury	1.0	0.1	30	**1E+01**	3E-02
On-Impoundment Soils	RF-ON-3D	Selenium	2.5	2	100	1E+00	3E-02
On-Impoundment Soils	RF-ON-3D	Silver	2.5	50	NA	5E-02	**NC**
On-Impoundment Soils	RF-ON-3D	Zinc	748.0	100	600	**7E+00**	1E+00
On-Impoundment Soils	RF-ON-3E	Aluminum	21,300.0	600	NA	**4E+01**	**NC**
On-Impoundment Soils	RF-ON-3E	Antimony	2.5	NA	NA	**NC**	**NC**
On-Impoundment Soils	RF-ON-3E	Arsenic	4.0	20	100	2E-01	4E-02
On-Impoundment Soils	RF-ON-3E	Barium	360.5	3000	NA	1E-01	**NC**
On-Impoundment Soils	RF-ON-3E	Cadmium	0.3	1.6	20	2E-01	1E-02
On-Impoundment Soils	RF-ON-3E	Chromium	21.7	0.4	100	**5E+01**	2E-01
On-Impoundment Soils	RF-ON-3E	Copper	21.3	40	150	5E-01	1E-01
On-Impoundment Soils	RF-ON-3E	Lead	21.0	140	900	2E-01	2E-02
On-Impoundment Soils	RF-ON-3E	Mercury	0.1	0.1	30	5E-01	2E-03
On-Impoundment Soils	RF-ON-3E	Selenium	2.5	2	100	1E+00	3E-02
On-Impoundment Soils	RF-ON-3E	Silver	2.5	50	NA	5E-02	**NC**
On-Impoundment Soils	RF-ON-3E	Zinc	62.0	100	600	6E-01	1E-01
On-Impoundment Soils	RF-ON-3F	Arsenic	23.0	20	100	1E+00	2E-01
On-Impoundment Soils	RF-ON-3F	Lead	231.0	140	900	**2E+00**	3E-01
On-Impoundment Soils	RF-ON-3G	Arsenic	12.0	20	100	6E-01	1E-01
On-Impoundment Soils	RF-ON-3G	Lead	23.0	140	900	2E-01	3E-02

Soil Invertebrate Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

* Average concentration across all depths; duplicate/split samples averaged with field samples.

Reach	Station ID	Parameter	Conc* (mg/kg)	Soil Invertebrate Benchmark (mg/kg dw)		Soil HQ	
				Low	High	Low	High
On-Impoundment Soils	RF-ON-3H	Arsenic	7.5	20	100	4E-01	8E-02
On-Impoundment Soils	RF-ON-3H	Lead	25.0	140	900	2E-01	3E-02
On-Impoundment Soils	RF-ON-3I	Arsenic	9.0	20	100	5E-01	9E-02
On-Impoundment Soils	RF-ON-3I	Barium	187.0	3000	NA	6E-02	**NC**
On-Impoundment Soils	RF-ON-3I	Cadmium	1.0	1.6	20	6E-01	5E-02
On-Impoundment Soils	RF-ON-3I	Chromium	20.0	0.4	100	**5E+01**	2E-01
On-Impoundment Soils	RF-ON-3I	Copper	25.0	40	150	6E-01	2E-01
On-Impoundment Soils	RF-ON-3I	Lead	127.0	140	900	9E-01	1E-01
On-Impoundment Soils	RF-ON-3I	Mercury	0.1	0.1	30	5E-01	2E-03
On-Impoundment Soils	RF-ON-3I	Selenium	2.5	2	100	1E+00	3E-02
On-Impoundment Soils	RF-ON-3I	Silver	2.5	50	NA	5E-02	**NC**
On-Impoundment Soils	RF-ON-3I	Zinc	209.0	100	600	**2E+00**	3E-01
On-Impoundment Soils	RF-ON-4A	Arsenic	81.0	20	100	**4E+00**	8E-01
On-Impoundment Soils	RF-ON-4A	Lead	1,350.0	140	900	**1E+01**	**2E+00**
On-Impoundment Soils	RF-ON-4B	Arsenic	11.0	20	100	6E-01	1E-01
On-Impoundment Soils	RF-ON-4B	Lead	63.0	140	900	5E-01	7E-02
On-Impoundment Soils	RF-ON-4C	Aluminum	18,900.0	600	NA	**3E+01**	**NC**
On-Impoundment Soils	RF-ON-4C	Antimony	2.5	NA	NA	**NC**	**NC**
On-Impoundment Soils	RF-ON-4C	Arsenic	12.5	20	100	6E-01	1E-01
On-Impoundment Soils	RF-ON-4C	Barium	240.0	3000	NA	8E-02	**NC**
On-Impoundment Soils	RF-ON-4C	Cadmium	2.5	1.6	20	**2E+00**	1E-01
On-Impoundment Soils	RF-ON-4C	Chromium	22.5	0.4	100	**6E+01**	2E-01
On-Impoundment Soils	RF-ON-4C	Copper	32.5	40	150	8E-01	2E-01
On-Impoundment Soils	RF-ON-4C	Lead	111.5	140	900	8E-01	1E-01
On-Impoundment Soils	RF-ON-4C	Mercury	0.5	0.1	30	**5E+00**	2E-02
On-Impoundment Soils	RF-ON-4C	Selenium	2.5	2	100	1E+00	3E-02
On-Impoundment Soils	RF-ON-4C	Silver	2.5	50	NA	5E-02	**NC**
On-Impoundment Soils	RF-ON-4C	Zinc	222.5	100	600	**2E+00**	4E-01
On-Impoundment Soils	RF-ON-4D	Aluminum	21,600.0	600	NA	**4E+01**	**NC**
On-Impoundment Soils	RF-ON-4D	Antimony	2.5	NA	NA	**NC**	**NC**
On-Impoundment Soils	RF-ON-4D	Arsenic	6.5	20	100	3E-01	7E-02
On-Impoundment Soils	RF-ON-4D	Barium	327.0	3000	NA	1E-01	**NC**
On-Impoundment Soils	RF-ON-4D	Cadmium	0.3	1.6	20	2E-01	1E-02
On-Impoundment Soils	RF-ON-4D	Chromium	22.5	0.4	100	**6E+01**	2E-01
On-Impoundment Soils	RF-ON-4D	Copper	28.0	40	150	7E-01	2E-01
On-Impoundment Soils	RF-ON-4D	Lead	17.5	140	900	1E-01	2E-02
On-Impoundment Soils	RF-ON-4D	Mercury	0.1	0.1	30	5E-01	2E-03
On-Impoundment Soils	RF-ON-4D	Selenium	2.5	2	100	1E+00	3E-02
On-Impoundment Soils	RF-ON-4D	Silver	2.5	50	NA	5E-02	**NC**
On-Impoundment Soils	RF-ON-4D	Zinc	80.0	100	600	8E-01	1E-01
On-Impoundment Soils	RF-ON-4E	Arsenic	7.0	20	100	4E-01	7E-02
On-Impoundment Soils	RF-ON-4E	Lead	20.0	140	900	1E-01	2E-02
On-Impoundment Soils	RF-ON-4F	Aluminum	21,900.0	600	NA	**4E+01**	**NC**
On-Impoundment Soils	RF-ON-4F	Antimony	2.5	NA	NA	**NC**	**NC**
On-Impoundment Soils	RF-ON-4F	Arsenic	6.7	20	100	3E-01	7E-02
On-Impoundment Soils	RF-ON-4F	Barium	218.5	3000	NA	7E-02	**NC**
On-Impoundment Soils	RF-ON-4F	Cadmium	0.8	1.6	20	5E-01	4E-02
On-Impoundment Soils	RF-ON-4F	Chromium	17.0	0.4	100	**4E+01**	2E-01
On-Impoundment Soils	RF-ON-4F	Copper	24.7	40	150	6E-01	2E-01
On-Impoundment Soils	RF-ON-4F	Lead	29.3	140	900	2E-01	3E-02
On-Impoundment Soils	RF-ON-4F	Mercury	0.1	0.1	30	1E+00	4E-03
On-Impoundment Soils	RF-ON-4F	Selenium	2.5	2	100	1E+00	3E-02
On-Impoundment Soils	RF-ON-4F	Silver	2.5	50	NA	5E-02	**NC**
On-Impoundment Soils	RF-ON-4F	Zinc	185.3	100	600	**2E+00**	3E-01
On-Impoundment Soils	RF-ON-4G	Aluminum	26,100.0	600	NA	**4E+01**	**NC**
On-Impoundment Soils	RF-ON-4G	Antimony	2.5	NA	NA	**NC**	**NC**
On-Impoundment Soils	RF-ON-4G	Arsenic	6.7	20	100	3E-01	7E-02
On-Impoundment Soils	RF-ON-4G	Cadmium	0.3	1.6	20	2E-01	1E-02
On-Impoundment Soils	RF-ON-4G	Chromium	20.0	0.4	100	**5E+01**	2E-01

Soil Invertebrate Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

* Average concentration across all depths; duplicate/split samples averaged with field samples.

Reach	Station ID	Parameter	Conc* (mg/kg)	Soil Invertebrate Benchmark (mg/kg dw)		Soil HQ	
				Low	High	Low	High
On-Impoundment Soils	RF-ON-4G	Copper	38.0	40	150	1E+00	3E-01
On-Impoundment Soils	RF-ON-4G	Lead	22.7	140	900	2E-01	3E-02
On-Impoundment Soils	RF-ON-4G	Mercury	0.1	0.1	30	5E-01	2E-03
On-Impoundment Soils	RF-ON-4G	Selenium	2.5	2	100	1E+00	3E-02
On-Impoundment Soils	RF-ON-4G	Silver	2.5	50	NA	5E-02	**NC**
On-Impoundment Soils	RF-ON-4G	Zinc	100.0	100	600	1E+00	2E-01
On-Impoundment Soils	RF-ON-4H	Aluminum	24,700.0	600	NA	**4E+01**	**NC**
On-Impoundment Soils	RF-ON-4H	Antimony	2.5	NA	NA	**NC**	**NC**
On-Impoundment Soils	RF-ON-4H	Arsenic	7.0	20	100	4E-01	7E-02
On-Impoundment Soils	RF-ON-4H	Cadmium	0.3	1.6	20	2E-01	1E-02
On-Impoundment Soils	RF-ON-4H	Chromium	24.0	0.4	100	**6E+01**	2E-01
On-Impoundment Soils	RF-ON-4H	Copper	28.0	40	150	7E-01	2E-01
On-Impoundment Soils	RF-ON-4H	Lead	29.0	140	900	2E-01	3E-02
On-Impoundment Soils	RF-ON-4H	Mercury	0.1	0.1	30	5E-01	2E-03
On-Impoundment Soils	RF-ON-4H	Selenium	2.5	2	100	1E+00	3E-02
On-Impoundment Soils	RF-ON-4H	Silver	2.5	50	NA	5E-02	**NC**
On-Impoundment Soils	RF-ON-4H	Zinc	115.0	100	600	1E+00	2E-01
On-Impoundment Soils	RF-ON-4I	Arsenic	17.0	20	100	9E-01	2E-01
On-Impoundment Soils	RF-ON-4I	Lead	344.0	140	900	**2E+00**	4E-01
On-Impoundment Soils	RF-ON-5A	Arsenic	13.0	20	100	7E-01	1E-01
On-Impoundment Soils	RF-ON-5A	Lead	42.0	140	900	3E-01	5E-02
On-Impoundment Soils	RF-ON-5B	Aluminum	18,400.0	600	NA	**3E+01**	**NC**
On-Impoundment Soils	RF-ON-5B	Antimony	2.5	NA	NA	**NC**	**NC**
On-Impoundment Soils	RF-ON-5B	Arsenic	4.3	20	100	2E-01	4E-02
On-Impoundment Soils	RF-ON-5B	Barium	198.0	3000	NA	7E-02	**NC**
On-Impoundment Soils	RF-ON-5B	Cadmium	0.3	1.6	20	2E-01	1E-02
On-Impoundment Soils	RF-ON-5B	Chromium	20.5	0.4	100	**5E+01**	2E-01
On-Impoundment Soils	RF-ON-5B	Copper	23.0	40	150	6E-01	2E-01
On-Impoundment Soils	RF-ON-5B	Lead	21.5	140	900	2E-01	2E-02
On-Impoundment Soils	RF-ON-5B	Mercury	0.1	0.1	30	5E-01	2E-03
On-Impoundment Soils	RF-ON-5B	Selenium	2.5	2	100	1E+00	3E-02
On-Impoundment Soils	RF-ON-5B	Silver	2.5	50	NA	5E-02	**NC**
On-Impoundment Soils	RF-ON-5B	Zinc	66.0	100	600	7E-01	1E-01
On-Impoundment Soils	RF-ON-5C	Arsenic	15.0	20	100	8E-01	2E-01
On-Impoundment Soils	RF-ON-5C	Lead	159.0	140	900	1E+00	2E-01
On-Impoundment Soils	RF-ON-5D	Aluminum	26,100.0	600	NA	**4E+01**	**NC**
On-Impoundment Soils	RF-ON-5D	Antimony	2.5	NA	NA	**NC**	**NC**
On-Impoundment Soils	RF-ON-5D	Arsenic	5.0	20	100	3E-01	5E-02
On-Impoundment Soils	RF-ON-5D	Barium	175.0	3000	NA	6E-02	**NC**
On-Impoundment Soils	RF-ON-5D	Cadmium	0.3	1.6	20	2E-01	1E-02
On-Impoundment Soils	RF-ON-5D	Chromium	36.0	0.4	100	**9E+01**	4E-01
On-Impoundment Soils	RF-ON-5D	Copper	26.0	40	150	7E-01	2E-01
On-Impoundment Soils	RF-ON-5D	Lead	23.0	140	900	2E-01	3E-02
On-Impoundment Soils	RF-ON-5D	Mercury	0.1	0.1	30	5E-01	2E-03
On-Impoundment Soils	RF-ON-5D	Selenium	2.5	2	100	1E+00	3E-02
On-Impoundment Soils	RF-ON-5D	Silver	2.5	50	NA	5E-02	**NC**
On-Impoundment Soils	RF-ON-5D	Zinc	87.5	100	600	9E-01	1E-01
On-Impoundment Soils	RF-ON-5E	Arsenic	2.5	20	100	1E-01	3E-02
On-Impoundment Soils	RF-ON-5E	Lead	15.0	140	900	1E-01	2E-02
On-Impoundment Soils	RF-ON-5F	Arsenic	12.0	20	100	6E-01	1E-01
On-Impoundment Soils	RF-ON-5F	Lead	25.0	140	900	2E-01	3E-02
On-Impoundment Soils	RF-ON-5G	Arsenic	20.0	20	100	1E+00	2E-01
On-Impoundment Soils	RF-ON-5G	Lead	333.0	140	900	**2E+00**	4E-01
On-Impoundment Soils	RF-ON-5H	Arsenic	9.2	20	100	5E-01	9E-02
On-Impoundment Soils	RF-ON-5H	Lead	52.0	140	900	4E-01	6E-02
On-Impoundment Soils	RF-ON-6D	Arsenic	17.0	20	100	9E-01	2E-01
On-Impoundment Soils	RF-ON-6D	Lead	135.0	140	900	1E+00	2E-01
Site Tailings	RF-TA-TP1	Aluminum	2,260.0	600	NA	**4E+00**	**NC**
Site Tailings	RF-TA-TP1	Antimony	50.7	NA	NA	**NC**	**NC**

Soil Invertebrate Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

* Average concentration across all depths; duplicate/split samples averaged with field samples.

Reach	Station ID	Parameter	Conc* (mg/kg)	Soil Invertebrate Benchmark (mg/kg dw)		Soil HQ	
				Low	High	Low	High
Site Tailings	RF-TA-TP1	Arsenic	219.0	20	100	**1E+01**	**2E+00**
Site Tailings	RF-TA-TP1	Cadmium	27.3	1.6	20	**2E+01**	1E+00
Site Tailings	RF-TA-TP1	Chromium	8.6	0.4	100	**2E+01**	9E-02
Site Tailings	RF-TA-TP1	Copper	522.2	40	150	**1E+01**	**3E+00**
Site Tailings	RF-TA-TP1	Lead	4,328.3	140	900	**3E+01**	**5E+00**
Site Tailings	RF-TA-TP1	Mercury	0.5	0.1	30	**5E+00**	2E-02
Site Tailings	RF-TA-TP1	Selenium	4.7	2	100	**2E+00**	5E-02
Site Tailings	RF-TA-TP1	Silver	18.5	50	NA	4E-01	**NC**
Site Tailings	RF-TA-TP1	Zinc	5,136.7	100	600	**5E+01**	**9E+00**
Site Tailings	RF-TA-TP2	Aluminum	3,986.7	600	NA	**7E+00**	**NC**
Site Tailings	RF-TA-TP2	Antimony	174.9	NA	NA	**NC**	**NC**
Site Tailings	RF-TA-TP2	Arsenic	308.9	20	100	**2E+01**	**3E+00**
Site Tailings	RF-TA-TP2	Cadmium	42.6	1.6	20	**3E+01**	**2E+00**
Site Tailings	RF-TA-TP2	Chromium	30.3	0.4	100	**8E+01**	3E-01
Site Tailings	RF-TA-TP2	Copper	475.1	40	150	**1E+01**	**3E+00**
Site Tailings	RF-TA-TP2	Lead	5,508.3	140	900	**4E+01**	**6E+00**
Site Tailings	RF-TA-TP2	Mercury	4.0	0.1	30	**4E+01**	1E-01
Site Tailings	RF-TA-TP2	Selenium	10.7	2	100	**5E+00**	1E-01
Site Tailings	RF-TA-TP2	Silver	40.8	50	NA	8E-01	**NC**
Site Tailings	RF-TA-TP2	Zinc	7,190.8	100	600	**7E+01**	**1E+01**
Site Tailings	RF-TA-TP3	Aluminum	1,987.2	600	NA	**3E+00**	**NC**
Site Tailings	RF-TA-TP3	Antimony	107.7	NA	NA	**NC**	**NC**
Site Tailings	RF-TA-TP3	Arsenic	224.3	20	100	**1E+01**	**2E+00**
Site Tailings	RF-TA-TP3	Cadmium	33.8	1.6	20	**2E+01**	**2E+00**
Site Tailings	RF-TA-TP3	Chromium	18.2	0.4	100	**5E+01**	2E-01
Site Tailings	RF-TA-TP3	Copper	253.5	40	150	**6E+00**	**2E+00**
Site Tailings	RF-TA-TP3	Lead	3,796.7	140	900	**3E+01**	**4E+00**
Site Tailings	RF-TA-TP3	Mercury	16.0	0.1	30	**2E+02**	5E-01
Site Tailings	RF-TA-TP3	Selenium	11.3	2	100	**6E+00**	1E-01
Site Tailings	RF-TA-TP3	Silver	23.8	50	NA	5E-01	**NC**
Site Tailings	RF-TA-TP3	Zinc	5,865.0	100	600	**6E+01**	**1E+01**
Site Tailings	RF-TSDD-GL50	Aluminum	13,377.8	600	NA	**2E+01**	**NC**
Site Tailings	RF-TSDD-GL50	Antimony	125.5	NA	NA	**NC**	**NC**
Site Tailings	RF-TSDD-GL50	Arsenic	197.4	20	100	**1E+01**	**2E+00**
Site Tailings	RF-TSDD-GL50	Cadmium	28.8	1.6	20	**2E+01**	1E+00
Site Tailings	RF-TSDD-GL50	Chromium	22.5	0.4	100	**6E+01**	2E-01
Site Tailings	RF-TSDD-GL50	Copper	311.3	40	150	**8E+00**	**2E+00**
Site Tailings	RF-TSDD-GL50	Lead	4,059.8	140	900	**3E+01**	**5E+00**
Site Tailings	RF-TSDD-GL50	Mercury	2.8	0.1	30	**3E+01**	9E-02
Site Tailings	RF-TSDD-GL50	Selenium	4.1	2	100	**2E+00**	4E-02
Site Tailings	RF-TSDD-GL50	Silver	26.0	50	NA	5E-01	**NC**
Site Tailings	RF-TSDD-GL50	Zinc	5,728.8	100	600	**6E+01**	**1E+01**
Site Tailings	RF-TSDD-GL52	Aluminum	14,027.0	600	NA	**2E+01**	**NC**
Site Tailings	RF-TSDD-GL52	Antimony	253.8	NA	NA	**NC**	**NC**
Site Tailings	RF-TSDD-GL52	Arsenic	321.8	20	100	**2E+01**	**3E+00**
Site Tailings	RF-TSDD-GL52	Cadmium	51.1	1.6	20	**3E+01**	**3E+00**
Site Tailings	RF-TSDD-GL52	Chromium	27.5	0.4	100	**7E+01**	3E-01
Site Tailings	RF-TSDD-GL52	Copper	620.0	40	150	**2E+01**	**4E+00**
Site Tailings	RF-TSDD-GL52	Lead	10,699.5	140	900	**8E+01**	**1E+01**
Site Tailings	RF-TSDD-GL52	Mercury	5.5	0.1	30	**6E+01**	2E-01
Site Tailings	RF-TSDD-GL52	Selenium	11.3	2	100	**6E+00**	1E-01
Site Tailings	RF-TSDD-GL52	Silver	39.8	50	NA	8E-01	**NC**
Site Tailings	RF-TSDD-GL52	Zinc	7,818.5	100	600	**8E+01**	**1E+01**
Site Tailings	RF-TSDD-GL53	Aluminum	16,151.5	600	NA	**3E+01**	**NC**
Site Tailings	RF-TSDD-GL53	Antimony	212.8	NA	NA	**NC**	**NC**
Site Tailings	RF-TSDD-GL53	Arsenic	319.7	20	100	**2E+01**	**3E+00**
Site Tailings	RF-TSDD-GL53	Cadmium	56.9	1.6	20	**4E+01**	**3E+00**
Site Tailings	RF-TSDD-GL53	Chromium	29.5	0.4	100	**7E+01**	3E-01
Site Tailings	RF-TSDD-GL53	Copper	678.5	40	150	**2E+01**	**5E+00**

Soil Invertebrate Hazard Quotients (HQs) for Direct Contact with Soils and Tailings

Richardson Flat Tailings Site
Screening Ecological Risk Assessment

* Average concentration across all depths; duplicate/split samples averaged with field samples.

Reach	Station ID	Parameter	Conc* (mg/kg)	Soil Invertebrate Benchmark (mg/kg dw)		Soil HQ	
				Low	High	Low	High
Site Tailings	RF-TSDD-GL53	Lead	10,533.5	140	900	**8E+01**	**1E+01**
Site Tailings	RF-TSDD-GL53	Mercury	10.6	0.1	30	**1E+02**	4E-01
Site Tailings	RF-TSDD-GL53	Selenium	13.3	2	100	**7E+00**	1E-01
Site Tailings	RF-TSDD-GL53	Silver	61.3	50	NA	1E+00	**NC**
Site Tailings	RF-TSDD-GL53	Zinc	9,420.0	100	600	**9E+01**	**2E+01**
Site Tailings	RF-TSDD-GL56	Aluminum	11,442.5	600	NA	**2E+01**	**NC**
Site Tailings	RF-TSDD-GL56	Antimony	89.2	NA	NA	**NC**	**NC**
Site Tailings	RF-TSDD-GL56	Arsenic	136.3	20	100	**7E+00**	1E+00
Site Tailings	RF-TSDD-GL56	Cadmium	23.3	1.6	20	**1E+01**	1E+00
Site Tailings	RF-TSDD-GL56	Chromium	21.5	0.4	100	**5E+01**	2E-01
Site Tailings	RF-TSDD-GL56	Copper	247.5	40	150	**6E+00**	**2E+00**
Site Tailings	RF-TSDD-GL56	Lead	2,897.5	140	900	**2E+01**	**3E+00**
Site Tailings	RF-TSDD-GL56	Mercury	1.8	0.1	30	**2E+01**	6E-02
Site Tailings	RF-TSDD-GL56	Selenium	2.5	2	100	1E+00	3E-02
Site Tailings	RF-TSDD-GL56	Silver	20.3	50	NA	4E-01	**NC**
Site Tailings	RF-TSDD-GL56	Zinc	4,518.5	100	600	**5E+01**	**8E+00**
Site Tailings	RF-TSDD-GL58	Aluminum	14,787.5	600	NA	**2E+01**	**NC**
Site Tailings	RF-TSDD-GL58	Antimony	58.3	NA	NA	**NC**	**NC**
Site Tailings	RF-TSDD-GL58	Arsenic	144.0	20	100	**7E+00**	1E+00
Site Tailings	RF-TSDD-GL58	Cadmium	22.7	1.6	20	**1E+01**	1E+00
Site Tailings	RF-TSDD-GL58	Chromium	21.0	0.4	100	**5E+01**	2E-01
Site Tailings	RF-TSDD-GL58	Copper	168.5	40	150	**4E+00**	1E+00
Site Tailings	RF-TSDD-GL58	Lead	2,622.0	140	900	**2E+01**	**3E+00**
Site Tailings	RF-TSDD-GL58	Mercury	2.6	0.1	30	**3E+01**	9E-02
Site Tailings	RF-TSDD-GL58	Selenium	11.3	2	100	**6E+00**	1E-01
Site Tailings	RF-TSDD-GL58	Silver	15.3	50	NA	3E-01	**NC**
Site Tailings	RF-TSDD-GL58	Zinc	3,378.0	100	600	**3E+01**	**6E+00**
Site Tailings	RF-TSDD-GL59	Aluminum	13,622.0	600	NA	**2E+01**	**NC**
Site Tailings	RF-TSDD-GL59	Antimony	168.3	NA	NA	**NC**	**NC**
Site Tailings	RF-TSDD-GL59	Arsenic	219.0	20	100	**1E+01**	**2E+00**
Site Tailings	RF-TSDD-GL59	Cadmium	24.0	1.6	20	**1E+01**	1E+00
Site Tailings	RF-TSDD-GL59	Chromium	24.0	0.4	100	**6E+01**	2E-01
Site Tailings	RF-TSDD-GL59	Copper	418.5	40	150	**1E+01**	**3E+00**
Site Tailings	RF-TSDD-GL59	Lead	3,834.5	140	900	**3E+01**	**4E+00**
Site Tailings	RF-TSDD-GL59	Mercury	13.6	0.1	30	**1E+02**	5E-01
Site Tailings	RF-TSDD-GL59	Selenium	6.1	2	100	**3E+00**	6E-02
Site Tailings	RF-TSDD-GL59	Silver	22.8	50	NA	5E-01	**NC**
Site Tailings	RF-TSDD-GL59	Zinc	5,462.0	100	600	**5E+01**	**9E+00**
Site Tailings	RF-TSDD-GL62	Aluminum	17,379.5	600	NA	**3E+01**	**NC**
Site Tailings	RF-TSDD-GL62	Antimony	45.3	NA	NA	**NC**	**NC**
Site Tailings	RF-TSDD-GL62	Arsenic	99.6	20	100	**5E+00**	1E+00
Site Tailings	RF-TSDD-GL62	Cadmium	20.1	1.6	20	**1E+01**	1E+00
Site Tailings	RF-TSDD-GL62	Chromium	22.5	0.4	100	**6E+01**	2E-01
Site Tailings	RF-TSDD-GL62	Copper	126.5	40	150	**3E+00**	8E-01
Site Tailings	RF-TSDD-GL62	Lead	1,572.0	140	900	**1E+01**	**2E+00**
Site Tailings	RF-TSDD-GL62	Mercury	0.7	0.1	30	**7E+00**	2E-02
Site Tailings	RF-TSDD-GL62	Selenium	5.9	2	100	**3E+00**	6E-02
Site Tailings	RF-TSDD-GL62	Silver	11.3	50	NA	2E-01	**NC**
Site Tailings	RF-TSDD-GL62	Zinc	2,981.0	100	600	**3E+01**	**5E+00**